

*A Semimonthly Technical Newspaper*

# ***Metallurgical & Chemical Engineering***

New York, March 1, 1917

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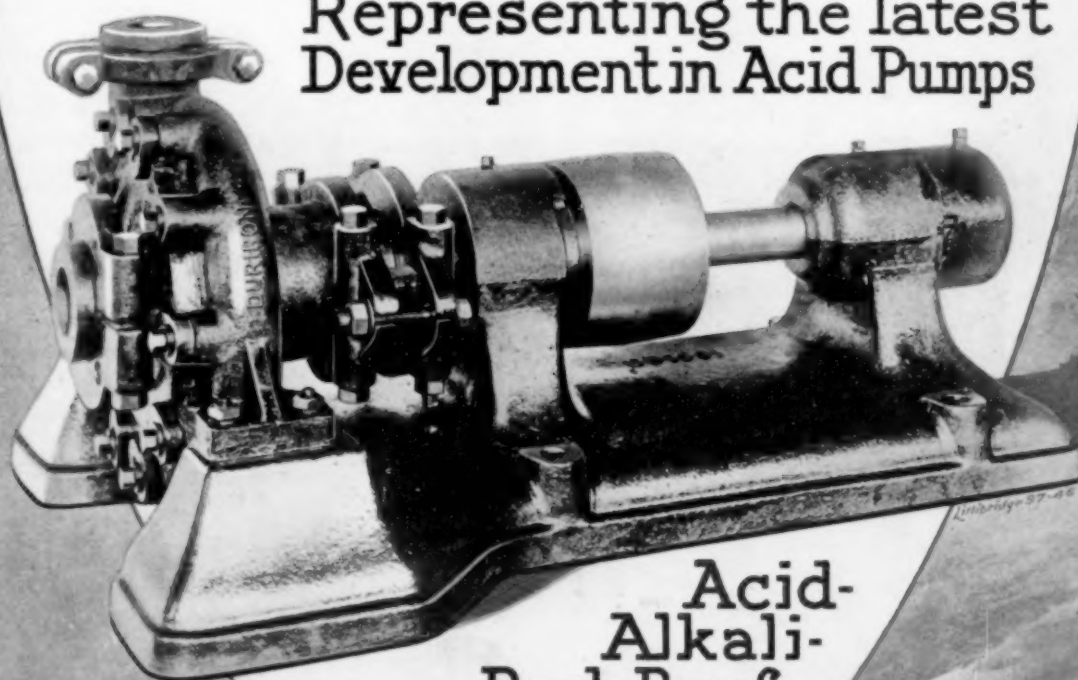
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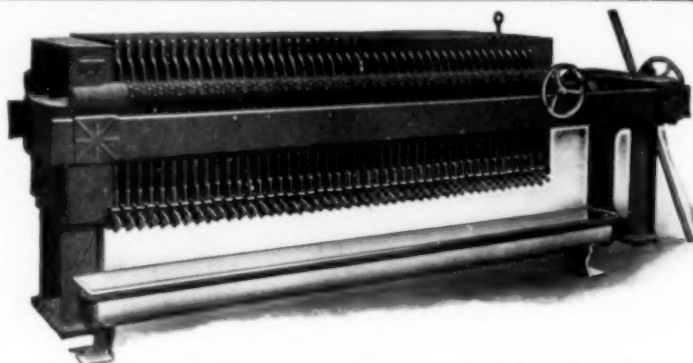
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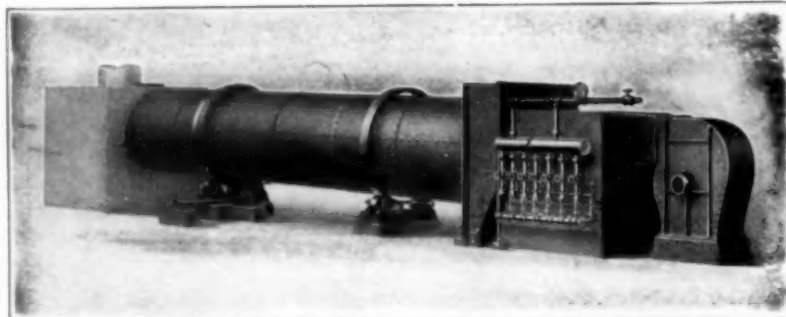
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# Metallurgical and Chemical Engineering

A Consolidation of  
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## Contents for March 1, 1917

### EDITORIAL:

Efficiency and Legislation.....	241
Our Export Trade.....	242
A Little Homily on Reading and Writing.....	243

### READERS' VIEWS AND COMMENTS:

The Niagara Falls Power Famine. By W. McA. Johnson.....	244
Research and Industry. By Parker C. Choate.....	244
Coming Meetings and Events.....	245
The Western Metallurgical Field.....	245
The New York Meeting of the American Institute of Mining Engineers.....	248
Nitrate Industry in Chile. By I. Berkwood Hobbsawm.....	253
The Analysis of Light Oils. By Gustav Egloff.....	259
The Determination of Zinc. By J. H. Hastings.....	263
Hydro-Electric Power and Electrochemistry and Electro- Metallurgy in France. By C. O. Mailloux.....	265
A Bibliography of Alloys: Binary, Ternary and Quarternary Systems Whose Equilibria Have Been Investigated. By Clarence Estes.....	273
Synopsis of Recent Metallurgical and Chemical Literature.....	282
Recent Metallurgical and Chemical Patents.....	284
A Mammoth Gyratory Crusher.....	286
A Remote Liquid Level Gage.....	287
Recent Developments in Operating Sugar Mills.....	288
PERSONAL.....	288
OBITUARY.....	289
Current Market Reports—The Iron and Steel Market, the Non- Ferrous Metal Market, Chemical Market and Price List..	289
Industrial—Financial, Construction and Operation, and Manu- facturers' Notes.....	293

## Efficiency and Legislation

In the engineering of a popular propaganda there is no more useful aid than a well known catch-word. In recent years one of the best words of this kind is "efficiency" which has been brought into considerable popularity by its association with such well advertised things as the manufacture of Ford cars, the German war machine, efficiency engineers, etc. So it naturally followed that those who professed to believe that the Falls of Niagara were running dry should use the efficiency motif in their propaganda. From this it would appear that the rapacious power companies and the greedy electrochemists were not only guilty of trying to ruin a great natural spectacle, but in order to do so were using the water in the most inefficient manner possible.

The great advantage of the efficiency argument was the element of truth contained in it. It is not so many years ago that just below the upper steel arch bridge at Niagara Falls there was a spectacular display of water going to waste and while to some this did not lack picturesque features, to others it suggested criminal waste, while to Mr. Taft and "the representative of the American Civic Association" it gave the impression of "the back yard of a house negligently kept." Certainly there was no denying that the water was not used efficiently. However, it should be observed that this water came from a power canal begun in the year 1853, long before modern hydro-electric construction had reached its present high state of development. Moreover the company owning the development was busily engaged in improving its construction as quickly as circumstances permitted and to-day a very high degree of efficiency has been reached.

As regards the other hydro-electric plant it must not be forgotten that when it was planned and its construction started more than a quarter of a century ago it was a unique development, involving new and difficult engineering problems demanding great courage to face successfully. Those responsible for its creation undoubtedly availed themselves of the best engineering ability to make the experiment successful and it certainly was not a failure. But with the knowledge gained in this pioneer work and with modern experience in hydro-electric design the water taken from the river could now be used with far higher efficiency. Indeed several years ago it would have been possible so to modify the construction of this plant that the water it uses would generate an amount of electric energy closely approaching that theoretically available.

As has been pointed out in these columns before, the plans for such a hydroelectric development have long been in existence, but their execution has been suc-



cessfully blocked by the propaganda of those who profess to be advocates of efficiency. With the addition of a relatively small amount of water to that at present diverted by this plant it would be possible to reconstruct it so as to make it capable of generating 200,000 hp. at the highest efficiency. The much more efficient use of the water in this way has, however, been successfully blocked by the Burton Act and the artificial extensions of its effect and thus the utterly deplorable present situation has come about and every one realizes that something has to be done.

Congress is now considering permanent legislation in reference to the diversion of the Niagara River. So far as the efficient use of the water allowed by the international treaty is concerned the proper course of legislation is obvious. The pioneers in the development, the plants now existing at Niagara Falls, should be enabled in the one case to use water to the full capacity for which it is constructed and in the other to use sufficient water to permit reconstruction so as to bring up the efficiency to the highest point attainable by engineering means.

We might well take an example from Canada where the ideal is the fullest development possible at the maximum efficiency. There a canal starting from the upper river will carry the water to Queenston Heights, thus taking advantage of the greatest head that can be obtained.

This also is the very ideal of the electrochemist since the future of his processes depends on a vastly increased production of electric energy. This should be the ideal of everyone professing a desire for preparedness for war and peace; but is this the ideal of the Washington politicians?

### Our Export Trade

Much of the comment made on our export trade during the war tends to produce an exaggerated notion of its character and volume. There is distortion by a psychological influence, the painful increase in the cost of living suggesting scarcity, and scarcity in turn suggesting that the United States has been drained of the things which we, the people, want to buy at a reasonable cost.

Nearly all the statistics of merchandise exports presented in discussions of our foreign trade are in figures preceded by the dollar mark. There is little to suggest quantity; much to suggest value. A collateral statistical fact is that the net vessel tonnage cleared from the United States in the fiscal year ended June 30, 1914, was 53,183,409 tons, while the amount cleared in the calendar year 1916 was 53,150,891 tons, or just the same. In each twelvemonth the vessels were no doubt laden to capacity.

The quantity, on the other hand, cannot have increased greatly. There may have been changes in the character of the merchandise, of course, by which goods of an average greater intrinsic value were shipped lately, and certainly the price per unit of the same goods has greatly advanced. It is unfortunate that with so many commodities it is impossible to present statistics repre-

senting quantities. When such are available they frequently fail to show the demand from the allied belligerents that one might expect. There are quantity statistics, for instance, showing the number of pairs of boots and shoes exported. There is an island near us, in which we take a fatherly interest, the "Pearl of the Antilles," and the ruthless statistics inform us that in 1916, as well as in December of that year, we shipped more pairs of boots and shoes to that island than we did to the next two countries, the United Kingdom and Italy, combined. Yet the cost of footwear in this country goes up.

Indeed, the statistics of vessel clearances show that destinations were much the same last year as in the twelvemonth before the war, about the same proportions to Canada, South America, Europe, and the other continents. There was a trifling decrease to Europe and a fair increase to Asia, which redistribution the Trans-Caucasian railway explains. The tonnage formerly going to Germany and Austria has been made up by the entente allies and that is about all that can be said in this respect.

As to the value of the trade there has also been a disposition to exaggerate. Making allowance for the relatively small merchandise trade balance in 1914, and other necessary corrections, we have grown richer with our foreign trade up to the beginning of this year by only about four billion dollars. Before a careful study was made there were estimates that five or six billions of American securities were held abroad and they were all expected to come back to us. Investigation showed, however, that the amount was considerably less than four billion, while only about one and a quarter billion has come back.

It is true that we have purchased of foreign securities about two and a quarter billion. That may seem like a large amount, but England alone has borrowed about eighteen billion. We are very far from being England's chief banker. As to gold, a distorted view may easily be obtained, because gold as a basis for currency is one thing and gold as a representative of wealth quite another thing. With the stream that has been poured into the country, we have not only more gold as a sum, but more gold per capita, than we had of all kinds of money two decades ago when our late Secretary of State refused to be crucified upon a cross of gold—because there was not enough of it. Our net gold imports in three years have been only about three-quarter billion dollars, which is a great deal for a circulating medium but does not represent much wealth. Our railroads alone are capitalized at 28 times as much. Let us as a nation keep our nether garments on and realize that we still must work. There is no escape from this conclusion.

No small part of our export trade has been in iron and steel. The value of iron and steel exports in 1916 was \$867,323,044, according to the Government classification, which does not include in the category agricultural implements, railway rolling stock (except locomotives), automobiles, etc., although these goods contain much iron and steel. The value stated was 16 per cent



of the total value of exports. On account of our very small imports of iron and steel, practically negligible, the contribution to the trade balance was much larger, 27 per cent.

### A Little Homily on Reading and Writing

It was the first lecture in the class in modern history at a leading American college which turns out good men. Its degrees are highly valued for good and sufficient reasons. The professor stated that he had no ambition to make his class letter-perfect in the dates of history; what he hoped to do was to give them a broader vision of the affairs of to-day and a better understanding of reactions in the mass of humanity. We appear, he said, to be at the brink of war, and the immediate cause of it may be the drowning of one or more citizens. But that, he continued, will be but the incidental cause; the real causes go back a hundred years; there are mistakes that have been made; cardinal mistakes, egregious blunders which, when they were committed, seemed marvels of astuteness, but which are the real causes of the present calamity.

In order to give the subject more vital interest and to make it more memorable to them he would make his lectures chiefly biographical; but for this they would need to have in mind a reasonable historical background. So he proposed to recall to them certain books with which they were probably familiar or, if not, to make them a part of their collateral reading. The parts played by men of mark in the chess-game of the peoples would then be understood.

He wondered how many had read Chesterton's Victorian Age. The class was large, but only two had ever heard the name of Chesterton. These two had also read the book mentioned. Trevelyan's Garibaldi, and the Thousand and The Making of Italy were inquired into. Of the same two students one had read Garibaldi and the Thousand, but none of the others had ever heard of Trevelyan. Thayer's Life of Cavour was totally unheard of and so was Edmund Gosse's Father and Son just as well as Money Penny's Disraeli.

They did not even know Mr. Brittling. One of the particular two had read Samuel Butler's Way of All Flesh and the other had looked at the title of Erewhon, but nobody else had ever heard of Samuel Butler. And so he proceeded through a popular list of the real contributions to literature made during the past ten or fifteen years that are indicative of the folkways. They were terra incognita to all but the two students we have mentioned.

Of all the books spoken of it is doubtful if any member of his class would have failed to finish a single one of them had he once begun to read it. They just did not know about them. They were typical Americans of good stock with the exception of the two who knew a book or two. Of these the one who had the better reading in English was born in Warsaw, Russia, and had first learned Yiddish and then Polish while the other was a young German, interned by the war in this country.

What's the matter with those American boys? They are fine fellows, sound young men, good students and they promise well, but the fact that they are ignorant of the literature of their own language, that they have no nose for that which bids fair to be permanent, shows something wrong.

We have no desire to hold the two foreign students up as having greater merit than the others. It is doubtful even if they have read more; the difference in this respect is that they have read good books, while the others have read trash. They had the good luck to strike something worth while that the others did not know about. Surely there is just as much sport in Garibaldi's life as there is in the imaginary career of any Dare-devil Dick who ever dodged bullets or rode an ostrich in a musical comedy. The explanation, we think, is to be found in one of those sequelæ of democracy which need constant watching. The foreign students were brought up to recognize authority. This may, and again it may not, have inhibited their initiative and narrowed their vision—that is another question entirely.

The only point we desire to make here is that, being accustomed to recognize authority, they betook themselves to the best available source of information as to what books they should read. The others didn't want any highbrow stuff put over onto them, and so they followed the lure of the magazines with their blurbs. The result is, they are not equipped to study contemporary history or even to express themselves in measures of grace.

Complaints are heard on every hand of good and competent engineers who are lacking in the ability to make clear reports or to state conditions so that intelligent laymen can understand them. They can work, but they can neither talk nor write. Sometimes the development of a great undertaking depends wholly upon their ability to talk or to write, and here is where they fall down. So the demand has become general for a larger measure of cultural studies and consequently for more time to be devoted to engineering courses. More or less radical changes have been proposed in the courses, but it is a question whether the solution can be found at all in that way.

Far be it from us to decry the beauties of classic lore, the marvelous treasures of Greek literature or the fascination of Gothic Days and the Renaissance. But some boys must hurry, really hurry, and the opportunity is not given them to take an arts course. Nevertheless, for every one who has taken his engineering degree and who lacks adequate general culture to speak or write without shaming himself, we can point to one or more bachelors of art who are no better off. Slipping through Greek and Latin will not turn the trick. On the other hand, we venture to say that any boy who comes to college with an established taste for that which is well and competently said in literature will not be at loss for the means to express himself when the time comes, no matter how much he may have had to skip and skimp by force of circumstances.

## Readers' Views and Comments

### The Niagara Falls Power Famine

*To the Editor of Metallurgical & Chemical Engineering*

SIR:—The relations between the government, the people at large, and the electrochemical industries of Niagara Falls have never been publicly and adequately explained, as far as I can see.

The fundamental psychology of the situation is about this. The people or the state own by the right of eminent domain, the Falls. They have a certain enjoyment of them at present and it is their own way of enjoyment. Now, it is all theirs.

If on the other hand the Falls, all or in large part, were used for power, they would see only factory buildings. Then, none of it would be theirs.

If, however, these factories were opened to the public in such a way that no substantial harm were done to private interests, "the beauties of electrochemistry" could be seen and enjoyed by some means by the people; then in due course the people would allow of an increasingly greater use of the Falls. The solution though easy in theory would be very hard in practice, but it can be done by such very able men as operate at Niagara Falls. But to me this psychology is sound.

In addition, I suppose that a tax would be placed on the power, for the trend of government is socialistic, not on Marxian lines, but by Socialism by Taxation.

W. MCA. JOHNSON.

Hartford, Conn.

### Research and Industry

*To the Editor of Metallurgical & Chemical Engineering*

SIR:—The comment in the paper of Dr. G. W. Thompson (issues of Jan. 15, p. 79, and Feb. 1, p. 149) on the personnel in the development of chemistry really involves the whole subject of research in chemistry and metallurgy. With such able introduction there should be discussion, which is part of his remedy, publicity.

Having spent a life in research involving contact with several large industrial bodies I may be permitted to present the fallacy of present industrial relations to invention or research, with a remedy, and aid in spreading the idea that inventors, industries, and as a consequence the people, are heavy losers, and handicapped in competition with more progressive nations, because of present conditions.

Our industrial corporations must finance research as they possess the only adequate capital and through them the country must get the practice and there must be profit to research and industry.

The industrial personnel is mentally a very different body from the research personnel. This is true both in the capitalists, salesmen and business whips that constitute the directorates, and in the engineers and superintendents and executives that conduct the manufacturing.

The mind that finds the way to do new and improved things must see visions that are entirely obscured to the minds that finance, direct, manufacture and market.

The university professor or the historian and statistician is not in the research class.

All these accept the results of research as existing, and depend upon it for future advance.

We must acknowledge the past existence and future necessity of a mentality that is necessary for civilization as it exists and must exist in any advance. Chemistry and metallurgy form a very large portion of this underlying creation.

It is ably said that the one thing that boards of directors cannot control or direct is invention. Let us define two or perhaps three kinds of invention or research.

First, we have the true scientific discoveries that are useful purely to the scientist, produced largely by our university professors, supported by salaries, and supplied with the adequate bench laboratory apparatus.

Second, we have the radical industrial invention that applies science, finds means and details, and requires in recent times large capital expenditures that are nowhere provided for; yet this is directly the basis of industry that earns dollars and means material saving in the efficiency of life. It is this class of practical invention that has the greatest dollar value and that is more especially the subject of this digest.

Third, we have the invention that maintains efficiency in present known industrial development, closely allied to testing and standardizing, and this department of research is attempted and represented by our many research equipments in universities and industrial laboratories.

The classifications mingle, and there are at least two examples where the second class of research is conducted by industries. But it may be said that a large part, perhaps more than half of the second class of invention, is derived from independent minds not corporation-ruled, as to where they must invent, or chained by the organization necessary in economical industrial practice.

These minds see the vision, design the details and describe the conditions, and appeal to an industry that is interested, to procure the perhaps large amount of money necessary to demonstrate. If they meet acceptance they are asked to assign all rights as a first step, and are offered a salary that may stop, and are promised some reward if successful, yet no definite time for test or degree of use or a tangible promise of any size is made irrespective of value in sight.

In all the forms offered to the inventor for development of research the control is demanded by capital, irrespective of the cash involved or the future prospects, and no adequate cash is promised to enable the inventor to perfect his demonstration on a convincing commercial basis.

The business end demands control of research development—the one thing it does not understand—and it holds the power to proclaim failure before the tests are half completed, and, if a success, it may squelch the invention or do with the minority as it chooses.

Outside of the business argument involving dollars which is always a war, let us consider the effect of this form of control over minds that are about to create a thing necessary for civilized progress—practical applied invention. The result of this control is to incapacitate research mentality and create a loss, and perhaps often a useless expense, simply because industry is trying to direct and govern research as it does direct manufacturing and salesmanship.

When research has completed its commercial demonstration, free from any dictation by business, then it is proper and right that business should have the entire direction as to the degree, time and means to be employed in the application.

There can and should be ample consultation, but the dictation and direction must be well defined, if we seek efficiency in results, and the reward of research must be its commercial creation, and the reward of business the profits of manufacture and sale. This is the pur-



pose of our patent laws. The community ultimately benefits. But how can we do this?

Mr. Thompson desires greater publicity so that there will be a popular demand for more recognition of research and he is entirely correct. But even if this is granted the dictation and impotent direction of the research mind by the business mind will produce as inefficient results in research attempts as would the direction of business by the research mind.

There are, of course, many solutions in practice and I will present one that seems in keeping with the times and about to be recognized as necessary. The incorporation of the Research Corporation of New York to impartially administer royalties has been successful and will be followed by many others on similar lines.

The recent decision of the Supreme Court in the flotation litigation shows that commercial invention put into practice will be protected.

But it would be much wiser if these valuable sustained patents were not held by private corporations solely for private gain, but were held by the inventor who would be sustained by the industries that desire to use the invention, while the royalties were administered in a mild, fair way by impartial boards. Such boards can be easily created as needed.

Large sums of money are needed and research demonstration must be on an adequate commercial scale, yet nothing is more demoralizing than an attempt to conduct research at a manufacturing plant or use the staff connected with manufacturing effort.

Large capital calls for union in research. Union research would mean that several manufacturers interested in lines that use some invention or series of inventions, went under contract to advance adequate sums of cash to a pure research corporation, which in turn would agree to try out and prove certain things desired, and perhaps others as discovered.

The impartial referee board would decide on the royalty, which is paid to the research corporation to sustain research and compensate the inventor and enable the patents to be defended in court. This condition in some form must arrive and it is much cheaper and a much better research incentive for industry to anticipate it and aid it than to fight private greed which will become possessed of inventions of value.

No inventor will hesitate to enter into an arrangement of this kind, and the abler ones will by necessity lead and direct. Business and capital must be kept out except in an assisting capacity.

The attitude of corporations is usually not intentionally to kill research, and men like Mr. Thompson are honest and sincere, whom any inventor could trust personally, but they are servants of an inert body not organized for research which body can only conduct research by the means of business they understand.

I have seen so much of what I state in my past thirty years of pure research effort in metallurgical lines that the exception will but prove the rule.

Let my advices not be misunderstood as though I was feeling that I underrate the industrial engineer or the operating staff, for in their line they are wonderfully able and absolutely necessary, but when they attempt to direct or conduct research the average is as much against them as when the research mind attempts to conduct manufacturing.

I trust I have brought out the great value of each type of mind, its necessary environment, and shown how easy it is to make each more efficient by a proper contract system of relations governed by a clearing house. Mr. Thompson, as I personally know him, freed from corporation cares would be one of those rarely constituted minds who could direct research.

Essex, Mass.

PARKER C. CHOATE.

## Coming Meetings and Events

American Chemical Society, New York Section, Twenty-fifth anniversary. Chemists' Club, New York, March 9, 1917.

American Chemical Society, spring meeting, Kansas City, Mo., week of April 9, 1917.

American Electrochemical Society, spring meeting, Detroit, Mich., May 2-5, 1917.

American Society of Testing Materials, Atlantic City, June 26-30, 1917.

Third National Exposition of Chemical Industries, Grand Central Palace, New York, week of Sept. 24, 1917.

American Electrochemical Society, autumn meeting, Pittsburgh, Oct. 3-6, 1917.

## The Western Metallurgical Field

### Mills

Throughout the mining districts of the North American continent new mills are being erected or plans made for the construction or enlargement of mills. This activity in the increase of the output of ore all over the country is a sure sign that both the mining and metallurgical industries anticipate a boom in their respective lines of business for the next few years.

The mill of the *A. R. G. Mining Company*. This is a new mill, operating in the Joplin district and is located on a tract off the Barrat land north of Duenweg. The mill is one of the most modern in the district, the crusher, rolls, hoppers, sludge tables, jigs and other machinery and equipment all being set on concrete base. This feature not only increases the life of the plant, but also gives a smoother running of the machinery. The jigs are composed of two four-cell roughers and one seven-cell cleaner. The sludge tables are run continually to catch the fine ore. The capacity of the plant is 400 tons per day. The ore treated is high-grade material, and the mill is so constructed as to eliminate all chat from the final product, which may run as high as 63 per cent metallic zinc.

Other innovations made in the Joplin district are: The rebuilding of the 200-ton mill of the *Near By Mining Company* and the erection of the new 300-ton mill of the *Adirondack Company*. The *Near By Mining Company* is reconstructing the L. J. Stephenson mill, which lies between Webb City and Cartersville. The mill needs little changing, the main features being the installation of electric power instead of steam and the addition of a few sludge tables for handling the fine ore. The new mill of the *Adirondack Company* lies in the western part of the Joplin district, and the construction is well under way and is of the most modern type.

The *Midvale Minerals Plant* is now in active operation. The plant was erected at the cost of \$100,000 and treats 300 to 400 tons of lead-zinc tailings per day. The mill is retreating the dump of the U. S. smelter at Midvale, Utah, the tonnage of which is so large that it is impossible to estimate it with any degree of accuracy. Other indications of an increase in the output of metals in the State of Utah are the erection of a 250-ton mill on the property of the *Keystone Mine* and the contemplated erection of a mill on the property of the *O. K. Silver* of Indian Springs in Tooele County.

In Canada, too, a lively increase in activity is noticed. A new high-grade mill is in operation at *The Mining Corporation of Canada*. The plant is an addition to the mill of the *Cobalt Reduction Company*. Previous to this the slimes from the concentrator were cyanided in the low-grade cyanide plant, and the sand concentrates were sent to the smelter. From now on the sand con-



centrates will be treated in the new mill together with the high-grade ores from the mines of the corporation, and in a short time all the shipments of the Canadian Mining Corporation will be in the form of high-grade bullion, which will be marketed in London. The new plant differs from the two other high-grade plants in the camp in that amalgamation plays no part in the process nor is the ore crushed in cyanide solution. The ore is first slimed in a tube mill, and after a preliminary treatment in two stages is de-watered and washed on an Oliver filter, then given a cyanide treatment and again filtered on a second Oliver. The silver is precipitated from the solution by means of sodium sulphide instead of aluminium dust. The silver sulphide is de-sulphurized, pumped to filter presses and refined in reverberatory furnaces to a high grade bullion, which is cast in bars and shipped to England.

The installation of a new mill is also under consideration at the *Lake Shore Gold Mines, Ltd.* The plans are now being worked out, and as the road of approach is rather difficult, it has been decided to have the necessary machinery hauled as soon as possible, so that construction may be started in the early part of next summer. The *British Columbia Copper Company* at present is erecting an experimental mill on the Similkameen River, which will be used for the working out of a concentration process preliminary to the erection of a 2000-ton plant at the same place.

### Copper

#### Prospective Increase of Copper Refining Facilities.

—A serious phase in the stage of the metallurgy of copper has faced this country for several months, namely, that the mine and smelter output has by far out-run the refinery capacity. The copper producers, while having made epoch-making sales, may find difficulty in making the required deliveries in the near future unless steps are taken to increase the number and capacity of the refineries in the United States. Having realized this dilemma, the "Boston News Bureau" has made a thorough canvass of the refineries for statistics bringing forth the actual prevailing conditions, a summary of which may prove of value. The following tables indicate the present monthly and annual capacities of the various refineries, and also the same after having completed the contemplated improvements and enlargements. The output is given in pounds per month and pounds per year.

	Present		Prospective	
	Monthly	Annual	Monthly	Annual
Am. Smelt. & R. Co. ....	76,000,000	912,000,000	115,000,000	1,380,000,000
Anaconda ..... 55,000,000	55,000,000	660,000,000	60,000,000	720,000,000
Nicholas ..... 35,000,000	35,000,000	420,000,000	40,000,000	480,000,000
U. S. Smelting... 17,000,000	17,000,000	204,000,000	20,000,000	240,000,000
Balbach ..... 5,000,000	5,000,000	60,000,000	5,000,000	60,000,000
Totals .....	188,000,000	2,256,000,000	240,000,000	2,880,000,000
	Monthly		Annual	
	Present	Prospective	Present	Prospective
American Smelt. & Ref. Co.:				
Baltimore ... 40,000,000	40,000,000	60,000,000	480,000,000	720,000,000
Perth Amboy... 20,000,000	20,000,000	25,000,000	240,000,000	300,000,000
Tacoma ..... 16,000,000	16,000,000	30,000,000	192,000,000	360,000,000
Totals .....	76,000,000	115,000,000	912,000,000	1,380,000,000
Anaconda:				
Raritan ..... 35,000,000	35,000,000	40,000,000	420,000,000	480,000,000
Gt. Falls, new 15,000,000	15,000,000	15,000,000	180,000,000	180,000,000
Gt. Falls, old. 5,000,000	5,000,000	5,000,000	60,000,000	60,000,000
Totals .....	55,000,000	60,000,000	660,000,000	720,000,000

These improvements, it is understood, will not be completed until about June, 1917, and a shortage in the delivery of the finished material is therefore anticipated by the producers.

**Copper from Mine Water.**—The Butte-Duluth leaching plant has resumed operations under the direction

of interests associated with the Ohio Copper Company of Utah. This plant originally recovered copper from mine waters by electrolysis of the sulphate solution. At present the copper is precipitated on iron scrap, giving as final product cement copper. This change from the electrolytic to the precipitation process is a marked advance in the economical handling of the mine waters, the electrolytic process having been one of the most expensive features of the Butte-Duluth plant. The iron used in the form of scrap iron, tin cans, etc., is collected throughout the vicinity and thrown into the troughs through which the mine waters circulate. It might be suggested in this place that in case of a shortage of scrap iron, etc., spongy iron would prove of great value.

### Platinum

**Platinum Indications in Colorado.**—The metal platinum so much desired in some of the chemical industries at the present is valued so highly that there is much interest in locating new sources for the production of this valuable element. At present there is undoubtedly a shortage in this country in metallic platinum and its salts, due to the fact that by far the largest amount of the world's platinum comes from Russia. Only a very small amount of platinum is produced in this country, and that comes mainly from the gold and silver bullion refineries. A. Lynn de Spain, chief chemist of the Burnhart Laboratories of Denver, states that platinum is found in the auriferous sands of the Iron Hill placer at Como, Col. In these sands the platinum is mechanically combined with magnetite. There is no doubt whatever that platinum also occurs in other localities of the State, as, for instance, in the black sands of Clear Creek. Little or no attention has been paid to the finding of platinum in Colorado, first because the rich gold finds have completely obliterated the importance of the other rare metals, and secondly, due to the fact that the average prospector is unable to recognize the metal or ores carrying the platinum. It is therefore essential that more attention be given to spread the characteristics of this metal so as to instigate the search for this metal by the prospectors.

### Ozokerite

**Ozokerite Plant at Soldier Summit, Utah.**—Previous to the European war practically all of the ozokerite used in the industries came from the province of Boryslau, Galicia, Austria. Although it was known since 1879 that ozokerite occurred near Soldier Summit and near Colton, Utah, little was done to develop these resources, due to the fact that it was impossible to compete with the Austrian output. Since the outbreak of the war, Austrian ozokerite is no longer on the market, and as this product has a great field of application the home sources and their successful operation became an item of paramount interest. The only known commercial deposit of this valuable material in the United States lies in Wasatch County, Utah. This deposit is approximately 2 miles in width and 12 miles in length. Further development indicates that the deposit also possesses great depth. The ozokerite occurs in fissures and brecciated zones caused by fracturing of the rocks. The deposits enlarge from mere films to 6 and 8 in., while deposits as thick as 3 ft. have been found. The country rock, as a general rule, is sandstone, while the fractured zone ranges from 10 to 200 ft. in width, the brecciated zone being permeated with seams, gashes, bunches and even bodies of practically pure ozokerite wax.

According to Heath M. Robinson, the Utah ozokerite is a mixture of hydrocarbons in various proportions, the exact nature of which is a subject of dispute. The

color of ozokerite varies from black or dark brown to light yellow, while some specimens of a greenish color have been found. It is plastic without being soft, and hard without being brittle. These latter qualities make it extremely valuable in some industries. The melting point of ozokerite lies between 58 deg. and 80 deg. C. It is soluble in ether, petroleum, benzine, turpentine and carbon bisulphide. Alkalies and the strongest of acids have no effect on ozokerite. It is an excellent non-conductor for electricity, and is therefore extensively used in making insulators. Being waterproof, it is used for lining tanks in which strong acid solutions are used. In the manufacture of candles ozokerite is used to give higher illuminating power. Wax figures and wax dolls are made of this material. Further applications for ozokerite are the manufacture of hard rubber, in electrotyping, in making phonograph records, in the manufacture of buttons, shoe polish, waterproof crayons, etc.

Ceresin, the refined product of ozokerite, is a substitute for carnauba wax, and is used in the manufacture of floor polishes, wax pastes, shoe and leather polishes, molding mass for copper and silver plating, wax for insulating electric cables, and composition for waterproofing cartridges. It is also used in making sealing wax, ceresin marking pencils, vaseline, cosmoline, molded ceresin candles and dozens of other products of industry.

Considering the wide scope of application of ozokerite and the sudden disappearance from the market of the foreign product, it is not to be wondered at that enterprises were undertaken to develop our own resources. For a year past the Wasatch Ozokerite Company has been in operation at Soldier Summit, Utah, endeavoring to put on the market their product. The treatment required to produce pure ozokerite is very simple as such, the main improvements being mainly along mechanical lines. Initially the company employed large vats, into which the crushed raw material was placed and subjected to treatment with hot water. This heat was sufficient to release the ozokerite from the adhering impurities. The wax, on rising to the surface was then skimmed off and poured into molds and allowed to cool. In this form the product was ready for the market. This mode of procedure proved rather inefficient, so that at present the company is operating steam-jacketed tanks in the treatment of the crude material. A new change is now contemplated by the company, namely, the installation of a cold-water process. The first unit of this process will raise the capacity of the plant from 10 tons of crude material to 60 tons per day. After completion the plant is expected to handle 1000 tons of crude ozokerite per day. With the present capacity of 10 tons of raw material, the plant is producing 400 lb. of ozokerite wax per day, which finds a ready market at 30 to 60 cents per pound.

The industry is undoubtedly here to stay, as it has been found that the deposits are much more extensive than was originally surmised, while the Galician deposits are known to have decreased enormously, and have also been damaged by the war to such an extent as to make their reworking very difficult. In the meantime the commercial development of the field in this country has made it possible to produce ozokerite wax and its refined products so cheaply that the home production will be able to compete with Austria, even though the Galician deposits be again put into operation after the war.

#### Company Reports

**Report of the Old Dominion Copper Mining & Smelting Co. for 1915.**—Due to the heavy repairs required at the mill and to the flotation work the cost per ton for

concentration was higher in 1915 than in 1914. The costs were \$1.215 for 1915 as compared to 0.932 for 1914. Much experimental work was done on flotation, and it was finally decided to use the Mineral Separation machine, but continue the investigation on other machines. Changes have also been made in the concentrator to reduce the power cost. These changes were justified on considering that the copper recovery for 1915 was 85.27 per cent, as compared with 73.55 per cent for 1914. The accompanying table summarizes the concentrating operations for the years 1914 and 1915:

	1915		1914	
	Dry Tons	% Cu.	Dry Tons	% Cu.
O. D. ore.....	32,560	3.72	30,101	4.69
Custom ore .....	140,486	4.48	121,792	4.67
Total and average.....	173,046	4.34	151,893	4.67

A comparison of smelting costs for 1915 with the previous year shows as follows, based on tons new charge smelted:

	1915	1914
Tons charge smelted.....	\$2.755	\$2.669
	206,549	207,595

The main items causing the increased cost per ton for 1915 were labor, repairs and increase in cost of flux. The coke consumption decreased 6 cents per ton of charge.

The cost of converting per ton of fine copper produced in bullion in 1915 compares with the previous year as follows:

	1915	1914
Pounds blister copper produced.....	\$5.36	\$5.65
	27,960,091	30,448,901
Pounds fine copper produced.....	27,736,158	30,210,361

The costs were decreased during the year, notwithstanding the fact that there were 2,500,000 lb. less copper produced in 1915 than in 1914. The saving was largely effected in the items of repairs. The cost of handling bullion in yards has been appreciably reduced. Of interest is the fact that the converter shell that was blown in on June 27, 1913, finally came off the stand on Dec. 7, 1915, after having produced 70,800,000 lb. of bullion. Due to the fact that there was no reserve stand to relieve it, and that the entire matte production of the smelter was handled by this shell, its campaign constitutes a most remarkable record. The lining costs per ton for the recently removed shell were \$0.055 per ton of bullion, while the best results that could be obtained under the old acid type practice was \$1.80 per ton of bullion.

**Eighty-First Meeting of Faraday Society.**—The eighty-first ordinary meeting of the Faraday Society was held on Monday, Dec. 18, 1916, at the Institution of Electrical Engineers, London. Sir ROBERT HADFIELD, president, and subsequently Prof. ALFRED W. PORTER, presided at the meeting. The papers presented were as follows: "A Carbon Tube Furnace for Testing and Softening Points and Compressive Strengths of Refractories," by Ezer and Edgar A. Griffiths (National Physical Laboratory); "Do Equilibrium Solutions in Iron Possess Equal Resistances?" by E. D. Campbell (University of Michigan); "Grain-Growth in Deformed and Annealed Low-Carbon Steel," by Ralph R. Sherry (Detroit, Mich.); "The Union of Glass in Optical Contact by Heat Treatment," by R. G. Parker and A. J. Dallaway; "The Effect of Pressure on the Equilibrium Constant of a Reaction in a Dilute Solution," by W. C. McLewis.

**Fellowship in Low-Temperature Coking.**—The American Creosoting Company has established an industrial fellowship at the University of Illinois. They have supplied the necessary funds for erecting an experimental coking plant.





PHOTOGRAPH TAKEN ON EXCURSION TO WEST POINT

## Annual Meeting of American Institute of Mining Engineers

The annual meeting of the American Institute of Mining Engineers was held in New York City from Monday, Feb. 19, to Thursday, Feb. 22, inclusive.

Technical sessions were held on both the mornings and afternoons of Monday, Tuesday, and Wednesday.

The annual business meeting was held on Tuesday morning. President Ricketts had been ill, and while he was present and on the platform he turned the chair over to Vice-President Prof. Joseph W. Richards. The minutes of the previous annual meeting and the various regular reports were read and passed. Dr. Ricketts said a few graceful words, but postponed the greater part of his speech for the banquet on Tuesday evening.

The result of the election of officers was announced as follows: President, Philip N. Moore of St. Louis, Mo.; vice-presidents, Charles W. Goodale and Mark L. Requa; directors, Robert M. Raymond, W. G. Miller, Allen H. Rogers, Howard M. Eavenson, and J. E. Johnson, Jr. Decision on the simplified spelling was reserved until the directors decide what to do with some 350 unmarked ballots.

Mr. Hennen Jennings read a short report on the activities of the Joseph A. Holmes Safety Association.

The presidential election this year furnished some real excitement for the members. When they received their ballots for marking they found not one name but two—one the regular candidate of the nominating committee and the other an independent whose name was placed on the ballot by virtue of his large number of petitioners. The race was very close, with Mr. Moore receiving something over 1200 votes and Mr. Sidney J. Jennings receiving between 1000 and 1100 votes.

The entertainment features started on Monday evening with a reunion smoker. The fifth floor of the Engineering Societies Building was crowded and the members were seated in groups according to the colleges which they represented. A treat was furnished in the form of moving pictures of the front in Europe, David H. Browne read some funny stories of boyhood days in Ireland, speeches were made by Messrs. Sidney Jennings, Philip N. Moore, R. M. Raymond and Herbert C. Hoover. Mr. Hoover was given a great reception.



PHILIP N. MOORE  
President American Institute of  
Mining Engineers

The annual banquet on Tuesday evening at the Hotel Astor was preceded by a reception to Dr. and Mrs. L. D. Ricketts and Mr. and Mrs. H. C. Hoover as guests of honor. At the banquet, speeches were made by the retiring president, Dr. L. D. Ricketts, by the president-elect, Mr. P. N. Moore, and by Mr. H. C. Hoover. The speeches were brief and the time saved by the omission of the usual long after-dinner speeches was spent in after-dinner dancing, which proved very popular and enjoyable.

On Wednesday evening Dr. Herbert T. Kalmus gave an interesting exhibition and lecture together with experiments on a new method of projecting moving pictures in colors, known as the technicolor process. On Thursday an all-day excursion was made by special train to West Point. An exhibition of riding by cadets was witnessed in the morning, luncheon was served in Cullum Memorial Hall, followed by dancing, and speeches were listened to in the afternoon in the auditorium of the Hall.

An exceedingly attractive program of events was furnished for the ladies under the supervision of the ladies' committee during all the days of the meeting. Mrs. H. W. Hardinge was chairman and Mrs. Bradley Stoughton, secretary.

## Grain Growth in Metals

This subject was discussed in the session on Metallography Monday morning, at which H. M. BOYLSTON presided. Two papers by Prof. HENRY M. HOWE and one paper by Prof. ZAY JEFFRIES were read. Professor Howe's papers were read by Professor Campbell. Professor Howe's first paper on "Recrystallization After Plastic Deformation" was a discussion of a paper by Mathewson and Phillips on brass presented last year. His other paper was a discussion of Mr. Jeffries' present paper on "Grain Growth Phenomena in Metals." Mr. Jeffries' paper was also a discussion of Mathewson and Phillips' paper. Mr. Jeffries' paper gives a very clear explanation of the phenomena of grain growth, and states that for every metal there is a temperature (designated the germinative temperature by Professor Howe) at which grain growth commences. The germinative temperature decreases with increase in deformation, and coarsening is influenced by the rate of heating, being greatly retarded by passing quickly through the germinative range. Another important





OF THE AMERICAN INSTITUTE OF MINING ENGINEERS

point is that the rate of coarsening is greater for a higher germinative temperature.

In the discussion on this subject Mr. W. F. Ruder said he had previously considered grain growth to be a critical strain phenomenon. He cited an experiment corroborating the statement that the germinative temperature decreases with increase in plastic deformation. Mr. Carter said he had made some experiments on platinum-iridium alloys. With pure platinum recrystallization occurred at about 1000 deg. C., with platinum-iridium at 1100 deg. C. or over, depending on the percentage of iridium. At 30 per cent iridium the grain does not grow with continuous heating to the same size as in a 20 per cent iridium alloy. Prof. J. W. Richards thought that metallurgists would find a great deal in Professor Bragg's work on crystals to aid in this study. (An article on Professor Bragg's work appeared in this journal July 1, 1916, page 35.)

#### Tungsten-Molybdenum Alloys

Two papers on this subject were presented in the same metallographical session, one by ZAY JEFFRIES and one by F. A. FAHRENWALD. Professor Jeffries described a new method of determining the melting points of tungsten and molybdenum alloys. A summary of Professor Fahrenwald's paper follows:

1. By compressing the mixed reduced powders of tungsten and molybdenum into briquets and then heating with an electric current in an atmosphere of hydrogen, alloys of this series were prepared varying in composition from 100 per cent tungsten to 100 per cent molybdenum.
2. The solidus curve for the series was located by means of optical pyrometer temperature measurements and checked by comparing the fusing current with a standardized wattage-temperature curve.
3. The equilibrium diagram for this series shows no critical points, appearing as resistance fluctuations, corresponding to a separation of a new phase. Its construction has been based upon this fact and upon results of microscopical analysis.
4. Curves for hardness, and for equiaxing temperatures, are smoothly convex, being typical of an uninterrupted series of solid solutions (mixed crystals).
5. As a result of thermal and microscopical analysis, the metals tungsten and molybdenum are reported to be completely isomorphous.
6. All alloys of this series are malleable and ductile under proper conditions.

In discussing Professor Jeffries' paper Professor J. W. Richards suggested that the logarithm of the wattage should be plotted against temperature instead of the wattage, thus giving a straight line instead of a curved line.

#### Milling and Smelting

This session was held on Monday afternoon, SIDNEY J. JENNINGS presiding. An interesting paper on "Magnetic Concentration of Low-Grade Magnetic Iron Ore" was presented by S. NORTON and S. LEFEVRE. The paper describes the Ball-Norton separators and discusses present practice at the plants of Witherbee, Sherman & Co. at Mineville, N. Y. Various other wet

and dry tests are described. The authors' summary is as follows:

The known and partially developed orebodies of New York and New Jersey could, if equipped with the best modern mining and milling machinery and using the best methods, produce at the present time 25,000 tons of 60 per cent iron ore per day. This can be delivered for an average freight charge of \$0.75 per ton from mill to tidewater. The operating cost of production should reach the "dollar rock" ideal of the Lake Superior Copper region, and the cost of mining and milling one ton of crude ore should be about \$1 for underground mining when handled in large quantities.

The ratio of concentration would be two tons of crude per ton of concentrates for an average. There are reserves of magnetic ore sufficient to double the above production, and then last probably 100 years.

In discussing the paper Mr. George C. Foote of the Witherbee, Sherman Co. said that 25 per cent ore is being worked successfully at Mineville, and that an even break financially could be expected on 20 per cent ore. Low-phosphorus ores are growing scarcer, and it is interesting to note that the phosphorus in the crude magnetite is reduced to one-half by magnetic concentration. The 0.02 per cent ore at Mineville is concentrated to 0.01 per cent P and 60 per cent Fe.

Mr. Birkinbine said that it was not to be inferred from the paper that all ores could be concentrated for 11 cents per ton. A coarse ore easily granulated can be concentrated. For the past year he has studied the lean magnetites in the East. In one section of Pennsylvania he found five different ranges of ore, showing the great diversity in the character of the ore. A great deal of experimentation is necessary before deciding on a process of ore treatment.

A paper on "Rock Crushing at McGill University" was read by JOHN W. BELL. It describes a series of tests on rock crushing, showing that Rittinger's law gives a better criterion for different machines as to crushing efficiency than does Kick's law.

A paper on "Counter-Current Decantation" was presented by LUTHER B. EAMES. This paper was published in full in our issue of Jan. 15, 1917, page 94. It was discussed by J. V. N. DORR.

"The Function of Alumina in Slags" was the subject of a paper by CARL HENRICH, who dealt with the matter from the standpoint of the iron blast-furnace engineer. His chief conclusions were:

In slags containing larger quantities of alumina, the alumina should be considered as an acid, replacing silica, and not as a base.

The higher the percentage of alumina, the nearer the slag should approach a "singulo-silicaluminate," i.e., the nearer the oxygen ratio of the bases should come to the combined oxygen of the silica and alumina.

An increase in magnesia calls for a higher percentage of bases, while absences of magnesia, and a pure limestone as a flux, will permit an approach to a "bi-silicaluminate" slag.

The safe way will be to start with a "sesqui-siliculate" as the type of slag to be produced,



which is approximately the slag actually, successfully and involuntarily.

In the discussion Mr. A. S. Dwight said he did not think that  $\text{Al}_2\text{O}_3$  should be considered either as an acid or as a base, but should be neutral, inert, non-combining, dissolving in the slag itself. In actual practice this was tried at El Paso in a lead furnace with good results, figuring alumina, fluorspar, and zinc oxide as inert constituents. He thinks experiments should be made on a large scale as well as in the laboratory in order to solve this question.

Mr. E. P. Mathewson said that in Colorado, running on high alumina ores from Cripple Creek, he left the alumina out of the calculations and got excellent results with a freely running slag. When calculating the alumina in, trouble was experienced.

Mr. Boggs said he had worked on slags where the  $\text{MgO} + \text{Al}_2\text{O}_3$  ran up to 18 per cent in making a 55 per cent Cu matte. He found that by neglecting the  $\text{Al}_2\text{O}_3$  below 10 per cent good results were obtained, but above that the slag would not run.

Prof. J. W. Richards said the title of the paper was too broad, as its subject matter referred only to alumina in iron blast furnace slags. Hence the qualifications do not apply to lead or copper furnaces. Mr. DWIGHT replied that the temperature in the lead blast furnace may not be high enough to form silicates of  $\text{Al}_2\text{O}_3$  and Zn as in iron furnaces.

"The Viscosity of Blast Furnace Slags" was discussed in a paper by Dr. ALEX. L. FEILD of the Bureau of Mines. The paper described a method of measuring the viscosity. In the discussion W. McA. Johnson said he thought the paper too theoretical. Dr. Feild said no attempt had been made yet to make a works instrument, but that would come later. Prof. R. H. Richards, Prof. J. W. Richards, George K. Burgess and Mr. Guess also discussed the paper.

A paper on "Matte Granulation at Herculaneum, Mo.," by S. P. LINDAU and H. B. SMITH was read for the authors by Arthur S. Dwight.

#### Silica Refractories

In the Tuesday morning session, over which Prof. HEINRICH RIES presided, an interesting paper on silica refractories by J. SPOTTS MCDOWELL of the Harbison-Walker Refractories Co. was presented describing a series of elaborate studies on the silica refractories. Some interesting lantern slides were shown describing the main features of the work. A fuller account of the paper is reserved for a future issue.

In the discussion Prof. J. W. Richards said that there are probably twenty different circumstances under which brick are used and the scientific study is extremely valuable. He called attention to the electrical conductivity, which was not mentioned in the paper. Mr. Henry D. Hibbard said he had had experience with silica brick in melting steel where pieces of the brick broke off instead of dripping down as customary. He thought insufficient mixing of the raw materials entering the brick might cause this failure.

#### Iron Blast Furnace Practice

Four papers were presented at the Tuesday afternoon session on iron blast-furnace practice, at which Prof. JOSEPH W. RICHARDS presided.

Two papers were presented by Messrs. LINN BRADLEY, H. D. EGBERT and W. W. STRONG of the Research Corporation, New York City. The first paper discussed the advantages of using a gas of higher flame tempera-

ture with improved stove design, together with the electrical method of cleaning the gas. The authors' second paper presented suggestions for the construction of hot-blast stoves along the lines discussed in their first paper. An abstract of the second paper will be found on page 283 of this issue. In the discussion Mr. F. H. Willcox said that dry-hot cleaning will probably be used to a large extent in the future when the gas is to be used under boilers. Mr. Breyer of the N. J. Zinc Company said they had considerable success with Tyson washers, scrubbing the gas which goes to boilers and stoves. The gas contains zinc oxide fume. He thought asbestos bags would probably be good when the hot gases are to be used after passing through the bags. He said that Messrs. Frazer and Chalmers of England are developing the asbestos bag-house system for hot gases, and have made several installations.

A paper on "Calculations with Reference to the Use of Carbon in Modern American Blast Furnaces" was presented by HENRY PHELPS HOWLAND. The paper was read by title. A communicated discussion by Professor Mathesius of Charlottenburg was read by the chairman, who also discussed the paper.

The paper on "Potash as a By-product from the Blast Furnace" by R. J. WYSOR was the subject of a long abstract in our Feb. 15 issue, page 205. Mr. Wysor showed some samples of the products from various locations at the Bethlehem Steel Company's plant at Bethlehem. The paper was discussed by Dr. Unger of the Carnegie Steel Company, who said they had made investigations of potash at many points. They used Lake Superior ore, Ohio and Pennsylvania limestone and Pennsylvania coke. This is somewhat different from the burden of the Eastern furnaces. The potash which they found was either insoluble or only one-third water soluble, and not enough to pay for recovery. They are at present making experiments around furnaces making ferro-manganese and ferro-silicon. The paper was also discussed by Messrs. Riddel, Breyer, Huston and Roush.

#### Flotation Discussion

The flotation session on Tuesday afternoon was presided over by EDWARD P. MATHEWSON. There was only one paper on the program entitled "Notes on Flotation, 1917," by J. M. CALLOW of Salt Lake City. Mr. Callow was in New York, but unable to attend the meeting, being engaged in a patent suit. His paper was therefore presented by Mr. H. A. Megraw who dealt especially with the notes on the Magma Sulphide Filming Plant. We herewith give this part of Mr. Callow's paper practically in full:

#### MAGMA SULPHIDE FILMING PLANT

The process in use in this plant is covered by Schwarz's U. S. patent 807,501, which is the first disclosure of the use of a soluble sulphide for converting an oxide of a metal into a superficial sulphide, and afterward recovering it by a flotation process.

Our earliest experiments were made with  $\text{H}_2\text{S}$  gas as the filming agent. A plant of 25 tons daily capacity was built. In this the gas was applied to the pulp by introducing it into the bottom of an open tank, having a mixing agitator. The results were encouraging, but the consumption of gas prohibitive—as much as 8 or 10 lb. per ton. The ore treated was the tailings of the Magma sulphide mill, which at that time carried considerable oxides. Occasional recoveries of 60 per cent (of the total copper) were made, but the results were erratic owing to the difficulty of getting uniform filming of the pulp with this method of applying gas. Then followed an interval of several months when we used sodium sulphide, calcium sulphide, and calcium sulphohydrate in an endeavor to avoid the use of gas, on the assumption that it was objectionable owing to the danger of its poisoning the surrounding atmosphere. This was true when attempting to use it in an open tank, much of it being lost in the atmosphere. During this time a number of





was also tried but none of these methods had anything to recommend them over the one adopted. Iron matte was never seriously considered on account of the recent high price of acid.

The flow sheet given in Fig. 1 is self-explanatory: The 6-ft. by 16-in. Hardinge ball mill has a capacity of 35 tons per day when loaded with balls requiring 35 hp., or 45 tons per day when loaded up to 50 hp. crushing from crusher run to 83 per cent — 150 mesh.

The power requirements are distributed as stated in Table II.

This is the equivalent of 37.6 hp.-hr. per ton, = 28 kw.-hr. per ton.

The plant is operated by four men for the three shifts, the extra man on day shift crushing the ore and hand sorting out any first-class ore there may be at the same time.

A general discussion on flotation followed. It was kept alive and rendered quite interesting enough through the energetic efforts of the chairman, Mr. Mathewson.

It was opened by Dr. Rudolf Gahl, whose long discussion was sent with Arizona enterprise by telegram and who answered some criticisms of his own former paper by Mr. Callow and in turn criticized some points of Mr. Callow's paper, particularly relating to the comparison of the Callow flotation machine and the Inspiration flotation machine. Dr. Gahl's long telegram was read in full by Mr. Robinson.

Mr. G. D. Van Arsdale expressed the opinion that ores should be divided for flotation into three classes; first, those requiring acidity of pulp; second, those requiring alkalinity of pulp, and, third, those requiring neutrality of pulp, and that there seems no doubt that this varying action is to be referred to the influence of the constituents of the gangue. He also brought out another important practical point, namely, the composition of mill waters and the effect of dissolved salts on flotation.

Mr. John V. N. Dorr read a discussion by Mr. E. R. Ramsey, relating to the handling of flotation concentrates and the use of the Dorr thickener and tray thickener.

Professor E. E. Free spoke on the theory of the flotation process and proposed the hypothesis that adsorbed films, formed previously to the application of the flotation oils, might explain many anomalies of flotation practice.

Professor J. W. Bell asked whether that would explain the necessity of using acid in many particular cases. Professor Free answered that no generalization of his hypothesis seems possible at present. Every case of adsorption has to stand on its own feet.

Mr. H. W. Dubois discussed flotation litigation. He asked: How can even the best courts as now constituted pass on such highly technical problems? Is it not like playing baseball with an umpire who has never seen the game? Does flotation really depend on the use of such a very small quantity of oil? Is there really a critical point in the amount of oil which makes the process effective? From his experience he concludes that there is no such critical point for certain classes of ore, though there may be for others. For certain classes of ore 2 or 3 or even 25 per cent. of oil will give as good results as less than 1 per cent of oil, and the use of the latter amount is merely a matter of economy.

Mr. G. D. Van Arsdale said he had never found a critical point nor did he see any reason for its existence. But certain apparatus may be better for certain amounts of oil.

Mr. J. V. N. Dorr referred to two Western companies which use more than 1 per cent of oil.

Mr. Mathewson told how in a particular case a flotation expert came and experimented for some weeks without conclusive results; when a little sulphuric acid was used it worked fine. Why? He also stated that excel-

lent results had been produced with more than 1 per cent of oil and that the use of less than 1 per cent of oil was simply a question of economy.

Professor R. H. Richards referred to flotation as a friend, not a rival of gravity concentration.

Mr. Dubois referred to bornite ore, which, according to Hoover, was difficult to float. But he found that acid helps, and his experiments showed that CO<sub>2</sub> bubbles attached themselves while the ordinary bubbles would not. Hence this is not the ordinary acid effect. Dr. Bell spoke of some similar experiments. Mr. H. W. Hardinge told a good story; Mr. Calbraith referred to mining as the fundamental industry, and after Mr. Dubois had pointed out that Japan had passed a law not to allow any flotation patents and that the fundamental U. S. patents for flotation had not been granted in Germany, the meeting adjourned.

### Manufacture of Iron and Steel

Mr. Henry D. Hibbard presided at the Wednesday morning session devoted to the manufacture of iron and steel.

"The Seasoning of Castings" was the subject of a paper by RICHARD MOLDENKE. An abstract of this paper will be given in our next issue. Mr. Outerbridge, Jr., of Philadelphia gave an interesting discussion of this paper.

A paper on "The Significance of Manganese in American Steel Metallurgy" was read by F. W. WILLCOX.

A paper on "Roll Scale as a Factor in the Bessemer Process," by A. PATTON and F. N. SPELLER, was read by Mr. Speller.

A paper on "Temperature Measurements in Bessemer and Open-Hearth Practice" was read by GEORGE K. BURGESS.

A paper on "The Manufacture of Weldless Steel Tires for Locomotive and Car Wheels" was read by GUILLIAEM AERTSEN.

### Metallography and Heat-Treatment of Steel

This session was held on Wednesday afternoon, ALBERT SAUVEUR presiding. The following papers were presented:

"Erosion of Guns—The Hardening of the Surface," Henry Fay.

"Notes on the Heat Treatment of High-Speed Steel Tools," A. E. Bellis and T. W. Hardy.

"Effect of Time in Reheating Hardened Steel Below the Critical Range," C. R. Hayward and S. S. Raymond.

"The Effect of Sulphur on Low-Carbon Steel," Carle R. Raymond.

"A Method for Distinguishing Sulphides from Oxides in the Metallography of Steel," George F. Comstock.

Professor Sauveur opened the discussion of Professor Fay's paper. He said that all the conditions necessary for case hardening were present in gun firing and that it should be taken into account. Mr. Hiram Maxim said a temperature of 4000 deg. Fahr. to 4500 deg. Fahr., was produced in a gun using nitrocellulose. Temperatures up to 6500 deg. Fahr., are obtained from mixtures of nitrocellulose and nitroglycerin. The products of combustion are under a pressure of 35,000 lb. per square inch. The caliber of the gun is increased 0.001 inch at every shot. Mr. Lawrence Addicks thought the thermal conductivity should be studied, as some steels have lower conductivity than others. Mr. Maxim didn't think there was time enough for much heat conductivity; Professor Richards said that by using alloys of iron with metals such as tungsten, boron, titanium, etc., which give a lower vapor tension, the life of the gun ought to be prolonged. Professor Fay replied to several questions.

## Nitrate Industry in Chile

By I. Berkwood Hobsbawn

So much attention has been drawn in recent years to the rapidly approaching death of the Chilean nitrate industry that it seems very much like "flogging a dead horse" to draw the attention of chemists, metallurgists and chemical engineers to it. In spite of this approaching "calamity," a description of this industry and an indication of its "re-birth" will not come amiss during a period such as this, when the prime output of the industry is of such vital importance.

Nitrate of soda, the substance which lends itself so equally to man's needs for both his peaceful and his war-like arts, is met with in nature in enormous quantities in the arid zone between the slopes of the Andes in the north of Chile and the foothills to the sea. This tableland, varying in altitude from 3000 to 7000 ft. above sea level, has been sufficiently described from time to time to need no further location or description here, but for years it has been the center of the production of nitrate of soda for the world's fertilizer needs.

Since its use was brought to the notice of the world in 1809 by Taddeo Haenke, a German domiciled in Bolivia, the export of nitrate of soda has exceeded a total of 53,000,000 long tons, and the present output is in the neighborhood of 2,500,000 to 3,000,000 long tons per annum. It will be agreed on this basis that the Chilean nitrate industry is one of very huge proportions, and at the same time, it must be asserted, that apparently little is known about it by the world in general in proportion to its importance or size.

As the attention of this country is being drawn very markedly to the value of nitrate of soda, both as a fertilizer and for other less peaceful purposes, and as the so-called exhaustion of the deposits in Chile, due in 1921 according to the "authorities," has been indefinitely postponed, it is very opportune to describe for the American readers interested in this particular product how nitrate of soda is obtained from the crude deposits and, further, to indicate how American progress in other directions and industries is being used to attempt the modernization of the methods in use in Chile, and to reorganize completely the means of procuring the refining of so useful a product. It would perhaps be as well officially to refute once and for all the statement so widely circulated in this country and in Europe that the nitrate deposits in Chile are very rapidly becoming exhausted.

The official report recorded below is that of Mr. Francisco J. Castillo (the inspector general of the nitrate deposits for the Chilean Government), which was issued in November, 1913, by the Chilean Nitrate Committee of London, England, under the auspices of the Chilean Embassy in that country.

### Nitrate of Soda Deposits in Chile

"According to the latest official report presented to the Chilean Government by Mr. Francisco J. Castillo, the inspector general of the nitrate deposits, the zone of nitrate-bearing grounds comprises 200,000 sq. km., of which so far only 5811 sq. km., that is to say, less than 3 per cent, are examined and their contents ascertained by excavation and test holes. These 5811 sq. km. belong to existing companies and private firms, and in part are still in the hands of the Chilean Government. The calculated contents of this 5811 sq. km. are 290,300,000 tons of nitrate of soda, of which up to the present 45,000,000 tons (1912) have been extracted and exported, leaving in the examined part of the area 245,300,000 tons of nitrate of soda, equal at the present

rate of production to a supply for a further hundred years. As the unexplored part is some thirty-four times larger than the explored grounds, it is safe to estimate that it contains altogether at least an equal quantity of nitrate of soda, and consequently the nitrate zone in Chile can certainly provide nitrate of soda for another 200 years at the present rate of production.

"The quantity of nitrate of soda in the examined grounds is subdivided as follows:

In the province of Tarapaca there remains.....	35,000,000 tons
In the Tocopilla District there remains.....	28,000,000 tons
In the Antofagasta (Central Dist.) there remains.....	32,000,000 tons
In the Antofagasta (Aguas Blancas) there remains.....	49,000,000 tons
In Chanaral and Copiapo there remains.....	8,300,000 tons
A total of .....	245,300,000 tons

"The inspector general of nitrate grounds in his report to the Chilean Government has arrived at these figures in the following way:

"In these examined grounds no raw material containing less than 11 per cent nitrate of soda has been taken into consideration, nor grounds where the thickness of the layer of raw material is less than 1 ft., except in the case of raw material of at least 25 per cent of nitrate of soda, where the thickness of 8 in. and above has been included.

"The superficial area of each portion of ground examined has been divided by the total number of test holes made in order to arrive at the area applicable to each test hole, and this consequently determines the total nitrate-bearing area.

"From this theoretical quantity of pure nitrate of soda resulting from the above operations, a reduction of 40 per cent has been made in order to provide for losses in extraction, manufacture, errors of calculation, etc. Of raw material of a lower grade vast quantities remain which have been excluded from these calculations because they cannot be profitably extracted under the present system of work, but as improvements are being constantly made there is every reason to assume that even this low-grade material will be worked when the richer qualities are exhausted."

*These statements, therefore, conclusively show that there is no fear of the Chilean nitrate deposits being exhausted for 200 years on the present basis of output and present efficiency of plant.*

Taking into consideration that during the last four years an enormous impetus has been given to development work in Chile, through one cause or another, and that many workers are engaged in attempting to apply the principles found successful in industries in other countries, it will be agreed that some measure of success attending these developments would not only increase the estimated 200 years in proportion to the increased efficiency which these new processes would give, but would also bring into consideration the material of less than 11 per cent, which at present is not included, by making it amenable to treatment.

This point does not need very much laboring for mining engineers to appreciate the huge quantities of material that will be brought into value if the process is able to use up anything above 5 per cent material. At the present day it is not only found advisable not to include 11 per cent and under in the estimated nitrate contents of the grounds, but more, in working these grounds, it is often impossible to take into the works material of 14 per cent and lower, and necessarily the raw material has to be hand-selected. In fact the limitations imposed upon the mining of nitrate of soda by the poor efficiency of the refining plants are such that where an average of 20-22 per cent nitrate is required for the refining plant very little material of less than 14 per cent can be used with richer material to make up the required average.



Under these circumstances, if a description of the actual work of the nitrate industry is given and an outline of the methods in use is drawn, subsequently followed by an indication of the direction in which it is hoped that higher efficiency shall be gained, it will then be appreciated what would be really effected by these changes, not only in regard to the methods of mining involved, but also to the operation of the whole of the industry itself.

The methods of refining nitrate of soda have been variously referred to as crude and primitive, but whereas these terms might well be applied to the actual methods of lixiviation and mining, the mechanical means for carrying out such do not come under these headings; in fact, were it not for the development of the mechanical side of the operations, it is very doubtful whether the industry could have been carried on to any profitable extent with the lower-grade material now in use.

In modern works the handling of the raw material and the generation of power for that purpose and for the disposal of the refuse has been developed on very modern lines. The methods of treatment of the raw material, however, do not yield a high efficiency for various reasons, and it is because of this low efficiency in the works that methods of mining of the raw material are very much restricted; in fact, take the average efficiency of the process as 50 per cent, and the refuse over all, accounting for 10 per cent nitrate, the minimum contents of nitrate in the raw material cannot, except in special instances, be less than 20 per cent. Twenty to 22 per cent is the general average of the material sent to the works for refining, and in order to gain this average ley of material from the grounds it is necessary to resort to hand-selection, such selection to a large extent depending upon the personal experience of the miner controlled by the general analysis performed in the factory. In this way the mining is costly and the percentage of nitrate taken out as raw material, out of the total of the deposits, comparatively low.

Raw nitrate-bearing materials are known locally under names which are supposed to denote the physical state and richness of quality. Caliche and Costra are the names mostly used, the former generally being the richer and purer, the latter being the poorer and the more impure. There is, however, no great consequence to be attached to these names at the present, as they are very often used interchangeably in different localities, but the name Caliche was originally applied to the kind of material containing very little insoluble matter and consisting essentially of nitrate of soda and common salt.

Caliche, however, may be considered to be the richer underburden, where costra is the poorer layer above it, it, in its turn, being usually overburdened by a layer of barren material.

The thickness of the deposits of both caliche and costra is variable, and at the same time both caliche and costra vary very much in physical structure, sometimes being hard and compact, sometimes soft and friable, and according to this nature can be sent to the works for refining with a nitrate content of 14 per cent and upwards. There are, however, qualities of costra which, even with contents of 22 and 25 per cent (and these might very well be called caliches), cannot be successfully treated by the processes in use to-day, because their compactness and imperviousness to water allows them to pass through the lixiviation process practically unaltered.

It is quite impossible to give a clearly defined description of what is costra and what is caliche, or to state any general rules as to which type of material should

or should not go into the works for refining. These factors are local and depend to a large extent upon the judgment of the manager of the works and the foreman and miners who are employed in removing the raw material from the grounds. For example, some types of stoney raw material with 10 per cent nitrate content may yield up all their nitrate to the attaching solutions, while other varieties of 15 per cent may only yield 4 per cent, or even nothing.

What is aimed at in the mining of nitrate-bearing raw materials is to get an average material as high in ley as possible, which will prove most amenable to the process of refining, yielding up to the solutions used for its lixiviation sufficiently high a proportion of its nitrate content while not causing too high a production of insoluble fines in the leaching tanks. This can only be attained by selection of material based on an extensive use of the personal equation.

It will be seen from this that so long as the present methods of refining are used, so long will the development of the mining of nitrate of soda on modern lines be delayed, and as a corollary so long will restrictions be placed upon the quantity of material which can be extracted from the grounds themselves.

The actual methods of mining of this raw material need not be gone into in detail in an article of this nature, but it might be sufficient to indicate that with the restrictions which have been referred to above there is very little possibility of being able to operate to advantage the mechanical methods of mining, which would so reduce costs of operation as has been found in other mining industries. It is even doubtful as to whether the modern methods of mining could ever be easily adopted in the Chilean fields in their entirety, assuming it were possible to treat an average grade of material of about 5 per cent. The main reason for this is the irregularity of the deposits, both as regards distribution and thickness.

The miners work on piecework, being paid a price agreed on for every cartload of suitable material passed to the works. The hand-selected material is loaded into carts holding from  $2\frac{1}{4}$  to  $2\frac{1}{2}$  short tons, the lumps weighing anything from 25 to 50 lb. It is kept as free from dust and barren overburden as possible, although a fair proportion of useless "smalls" is often brought in with the selected material. An average analysis of 22 per cent caliche used in the process might be taken as below:

Nitrate as nitrate of soda.....	22 per cent
Chloride as chloride of soda.....	20 per cent
Sulphate as sulphate of soda.....	4 per cent
Insoluble matter .....	54 per cent
100 per cent	

The nitrate is present as nitrate of soda, potash, lime, magnesia, though all of these bases are not necessarily always present.

Chlorine is also present allied with traces of these other bases, and sulphates of lime and magnesia are also present in varying quantities.

#### Method Employed in the Refining of Chile Saltpetre from the Raw Materials

In the most modern of the Chilean works the methods adopted to-day actually differ very little from those used thirty years ago. The principle on which the method is based depends upon the fact that sodium chloride is not sufficiently soluble in concentrated boiling solutions of nitrate of soda to contaminate the latter seriously when the solution is cooled in order to crystallize it. That is to say, that a saturated solution of salt, when warmed up and subsequently raised to the maximum boiling point in the presence of nitrate of



soda will take up the latter and deposit the salt to such a point that the nitrate of soda can be crystallized from the solution obtained by cooling, and the crystals obtained will be commercially free from sodium chloride contamination.

The raw material is passed through jaw crushers of the Blake-Marsden type, and the crushed material is lifted to the boiling tanks either by belt conveyor, bottom emptying car and hoist (electrical or hydraulic), or drawn up an inclined plane in a side tipping or bottom emptying car. Where a belt conveyor is used the actual distribution of the material to the tanks is done by means of the cars above referred to or, as in some cases, by belt distribution. The tanks, 32 ft. x 9 ft. x 8 ft., provided with false bottom 9 in. to 12 in. from the true bottom, three doors in the bottom for discharging ripio (refuse), steam coils for heating purposes and connections for transferring liquors and running off finished liquor and washes, are loaded with the crushed material. The size of crushing is varied, according to the hardness of the raw product, from 3 in. for the softest to  $3\frac{1}{4}$  in. for the hardest types.

The charge weighs anything from 60 to 70 tons. It is now leached in stages, usually four or five operations being necessary. The first is with the strongest liquor available, which is obtained from the tank immediately behind and whose origin will be seen from the description of the complete cycle, and this is carried out at the highest temperature to be obtained, the boiling being continued for a period of from two to three hours, according to the grade of material under treatment.

At the expiration of this period the boiling liquor, which is now strong enough to send to the crystallizing tanks, is slowly run off from a point about half way up the tank, the level of the liquor in the tank being maintained by feeding with the next strongest liquor from the tank behind. The "caldo," as it is called, is run off slowly for a period of from two to three hours, boiling and feeding being maintained all the time, and the flow is only stopped when the liquor has decreased in strength, due to the weaker feed not being able to be strengthened quickly enough in the boiling tank which is under review.

The feed liquor is intended to *replace* the caldo running off, but in actual practice it mixes with it and thus limits the efficiency of the operation. When the flow of caldo is stopped, "cut," the feeding liquor is stopped and the liquor in this tank is transferred by pump or by leveling action (or both) to the next tank forward, which contains fresh caliche, and the preparation of caldo proceeds anew from this fresh caliche. The tank which has now been boiled once is filled up with liquor from the tank behind it (this liquor is the result of the second boiling of this material in this tank) together with mother liquor from the crystallizing tanks and boiled for a further period during which the fresh caliche in the tank forward is being boiled for the first time with the liquor it has received from the tank under description, while the tanks further back are receiving their third, fourth and fifth treatment or washing. In this way the caliche is successively leached with four or five liquors in a cycle of operations, the first two leachings being at the boiling point, the third and fourth at lower temperatures, the final wash water being cold water. The whole operation takes eighteen to twenty hours per tank. The spent caliche, after draining, is discharged into wagons and deposited on the dump tips; the drained liquor being passed forward in the system in due course.

The strong liquor (caldo) is run into settling tanks, where it is clarified sometimes by "time" settling only,

sometimes with the aid of flour, dung, etc., and the clear liquor is decanted off into open troughs, through which it is conducted to the crystallizing tanks.

These crystallizing tanks are 15 ft. x 15 ft. x 2 ft. 6 in. x 3 ft., sloping to one side, and an outfit of these tanks is enough to allow of sufficient being filled each day and occupied for twelve to thirteen days, with a two days' supply in reserve. Thus a works filling ten tanks a day will require about 150 tanks for its equipment.

The cooling is done by exposure to atmosphere, and takes eight to eleven days, at the expiration of which the plugs, which are fitted in the bottom, are withdrawn, and the mother liquor drained off to open troughs below, which conduct it to the mother liquor stock tank. From here it is sent back to the system as above. The crystalline deposit in the tanks is equal to about 25-35 lbs. nitrate from 1 cu. ft. caldo, and for every 1 lb. nitrate deposited as crystal about 0.5 lb. returns to the system as mother liquor. The nitrate after draining contains 8 to 10 per cent liquor, and the crystals are heaped on the drying floors (into which some of the mother liquor drains and is lost), where the heaps are periodically raked over in order to expose more surface, and by atmospheric evaporation and draining over a period of a month the crystals are reduced to 2 to 3 per cent moisture contents, after which the lumps are broken down with wooden mallets and the nitrate filled into sacks, each holding about 200 lb., for entrainment to port.

In 1911 an English nitrate company began the construction of a new refining works (Oficina), which was designed for an output of 90,000 qtl. nitrate per month from material containing 25 per cent of nitrate of soda.

In this works the whole of the power for crushing and distribution of crushed material and for pumps was provided by a central electrical generating station containing two 200-b.-hp. Diesel engines direct coupled to two three-phase alternators of Siemens Brothers. For the transmission of power to the wells and outlying places step-up transformers are used and the current transmitted on bare copper aerial lines.

The steam for process work was generated by oil-fuel-fired Lancashire boilers, of which five were installed (30 ft. x 7 ft. 8 in.).

The material was crushed in Blake-Marsden crushers, driven electrically, five of these said crushers being installed (24 in. x 18 in.).

The crushed material was elevated to the boiling-tank stage by belt conveyors and distributed by belt to the tanks for loading. There are eighteen boiling tanks, each 34 ft. x 7 ft. 6 in. x 8 ft. 6 in., provided with false bottoms 1 in. above true bottom, fitted with the necessary connections for transference of liquors and three ripio discharge doors for discharging the spent caliche. The latter is drawn to the dump tip side-tipping wagons drawn by petrol locomotives. The plant is equipped with 154 crystallizing tanks, each 18 ft. x 18 ft. x 3 ft. 6 in., sloping to 3 ft., the whole of these mounted on a substantial steel structure. The raw caliche is brought into the works by a light railway, 2-ft. 6-in. gage, 35-lb. rails spiked being used, drawn by locomotives constructed by North British Locomotive Company, Limited.

The mileage of railway in the grounds is  $2\frac{1}{2}$  miles, and the loading stations are fed by carts and mules from the actual mining localities.

The water supply is derived from wells, as is usual in these districts, the power for pumping being supplied from the central station.

The plant is equipped with a very complete engineering workshop fully capable of dealing with all necessary

repairs for the efficient upkeep of so large a mechanical installation. It is also equipped with a small foundry for both brass and iron.

A description of one month's working will show what results are obtained in actual operation.

During twenty-nine days worked in one particular month there were brought in 12,484 cartloads of raw material.

Estimated weight of cartload 41 Spanish quintals (101.2 lb.), fifteen carts were employed in feeding the loading stations, each making about twenty-eight trips per day. Two locomotives and sixty-five side-tip wagons were used to transfer the material from the loading stations to the treatment plant.

The raw material averaged 21.89 per cent nitrate, and the total treated 499,544 Spanish quintals were divided into 350 charges (tank loads) of about 1430 qtl. each, and the yield showed, on the figures taken, an efficiency of 56.4 per cent. The figures are as follows:

Total caliche 499,544 qtls. at 21.89 per cent nitrate	
equals 109,350 qtls. nitrate	
produced 85,000 qtls. of 95 per cent nitrate	
equals 61,750 qtls. nitrate	
<b>LOSSES</b>	
In ripio 400,644 qtls. (dry weight, estimated) at 5.04% . . .	20,192.45
In Borra 33,900 qtls. at 17.45% nitrate . . . . .	5,915.55
Unaccounted for . . . . .	21,492.00
	<b>47,600.00</b>

A recovery of 56.4 per cent of the nitrate contained was effected from raw material of about 22 per cent.

For each quintal of petroleum consumed 7.98 qtl. of nitrate were extracted, or in coal equivalent (taking the heat efficiency oil to coal as 18 to 12) 1 qtl. of coal produced 5.32 of nitrate.

With such a material as caliche this countercurrent system does not give most efficient results for a variety of reasons, chief among which are:

1. All liquors passing forward are saturated solutions of salt and nitrate at their temperature, and as they take up more nitrate with rise in temperature they deposit salt. When this salt is deposited around the lumps of caliche, it tends to act as a protective coating against the action of the succeeding liquors, which are themselves, as shown, saturated with salt.

2. The circulation in the tanks is very poor, for the tendency of the solid is to pack close during leaching, and hence the liquors passing through the charge will endeavor to take the line of least resistance. Under these circumstances, channels are liable to be formed in the solid, thus permitting certain of the contents of the tank to escape lixiviation altogether.

3. The solid on yielding up its nitrate to the attacking solutions loses the binding agent which has kept it in lump form, and the lumps fall apart in the form of sand, stones and clay, which were bound together in solid form by the crystals of soluble nitrate, etc.

The result of this is that it becomes exceedingly difficult to drain off the liquor from the solid, and thus every successive wash becomes a dilution of stronger liquor contained by the weaker following one, and as the final draining is equally poor, the net result is to dispose of the refuse containing not only undissolved nitrate, but a very high proportion of nitrate liquor containing.

During the course of the operations the space referred to between the true and the false bottoms becomes filled with the finest of the particles of the insoluble matter, which have found their way through the perforations in the false bottom. This is known as borra. This space was originally intended for the reception of this fine sandy matter, in order to keep the bulk of the charge free from it, but it is not sufficient nor can it be made sufficient to take the whole of the

fine matter produced during the disintegration of the raw material of leaching. Very slow passage of liquors during the leaching process tends to check this disintegration.

The more the material is leached the more of these fines will be produced, until eventually the whole of the raw material will be reduced to this fine state, when all the soluble matter has been dissolved.

When the design of this type of leaching tank was first introduced, the raw material contained quantities of insoluble matter varying between 10 and 25 per cent. Nowadays this percentage varies between 50 and 70, and the tanks have not been redesigned to cope with this additional quantity of insoluble matter. The fine sand and slime thus deposited remains wetted with the strongest liquor, and even after washing is discharged with about 18/24 per cent nitrate. That which cannot get to the bottom remains in the charge and causes it to retain more nitrate liquor than otherwise, thus making the spent charge wetter and richer and increasing the inefficiency of the process.

As a result of the operation of this method of lixiviation, only about 45 to 55 per cent of the nitrate contents of the raw material are extracted as crystal, and an average oficina's working on 20 per cent material might be tabulated as follows, taking a unit of 1000 tons:

General Statement of Work Done in Nitrate Plant		
Nitrate contents, original . . . . .	Tons	Per cent
	200	
Nitrate extracted . . . . .	100	50
Nitrate in Ripio (refuse) . . . . .	40	20
Nitrate in Borra (fines) . . . . .	20	10
Nitrate unaccounted for . . . . .	40	20
	<b>200</b>	<b>100</b>

In some of the still more modern works, owing to very large quantities of raw material handled (1500 to 2000 long tons per day), material as low as 18 per cent average is being worked successfully, and this success is due to the attention to and development of the mechanical side of the work, thus diminishing cost of power and labor, and by the size of the installation diminishing the proportion of fixed overhead charges.

No attempt will be made to enter into the question of costs in this article, except to say that with the general high cost of mining and of labor and fuel on the lixiviation plant the costs of operation are high. This coupled with the low efficiency of the whole scheme leaves a comparatively open field for new processes and methods of operation.

The foregoing will have given sufficiently clear an outline of the methods in use to-day for the refining of nitrate of soda, in which about 170 plants are engaged, ranging in output from 1500 tons to 7500 tons per month each, these including old type of machinery and the most modern of installations.

### New Projects

As stated previously, within the last four years or so a huge impetus has been given to the interest taken in the improvement of the methods of refining, and a large number of projects have been suggested for this purpose.

A number of these schemes are in process of being tried on the large scale, while laboratory work is still being pushed forward in this direction.

The writer will endeavor to give an outline of the direction in which the work is tending, and although it will not be possible to refer to the inventors and workers by name it will readily be realized how near is the solution of the problem which is being tackled by numbers of workers who are transferring their knowledge of chemical, mining and metallurgical proc-



esses and adapting them to the needs of the nitrate industry.

The problem has been attacked from many points of view, and for clearness of description these may be divided into two classes:

- (1) Auxiliary processes.
- (2) Complete processes.

#### Auxiliary Processes

Auxiliary processes may be subdivided into various classes, but as a general statement it may be said that an auxiliary process is one which has been designed to remove some of the salient difficulties of the old process and to assist the latter to obtain better and cheaper production.

The subdivision of auxiliary processes may perhaps best be made as follows:

- (1) Those which have as their basis the screening of the raw material before treatment in the main plant.
- (2) Those which have as their basis the further treatment of the refuse material from the main plant.

Although the methods pursued by these two classes of auxiliary processes differ according to the nature of the prime material they deal with, their objects are the same inasmuch as they aim at procuring a liquor which can be strengthened to the necessary point for crystallization by being passed over raw material in the old type of plant.

#### SCREENING (AUXILIARY) PROCESSES

Such processes are based on the idea that one of the main causes of the inefficiency of the present method of lixiviation is the presence of "fines" in the crushed raw material, these fines being present in such material partly due to the crushing, partly to the breaking down of the conglomerate during blasting in the mining and falling in of soft overburden, and also to the natural friability of some of the material and the breaking down of it during handling.

By screening in rotary screens after crushing, and using about 3/16 mesh, varied proportions of fines are separated out of the varied crushed materials, but it is generally assumed that a cleaner and better leaching can be obtained in the old type of plant when it is fed with a screened product. No doubt this is true to some extent, but, as the leaching itself causes the production of fines in the tanks, the good results from the above will depend to a large extent on the nature of the raw material being treated in the original plant and will necessarily be limited by this.

From this point the methods adopted in the auxiliary processes for the treatment of the fines may be divided into three classes, depending as to whether

- (1) Grinding and vacuum filtration,
- (2) Pressure filtration, or
- (3) Classification and partial filtration

is adopted as the basis of the method of treatment.

In the first of these methods of treatment the fines (3/16 mesh) are ground in a ball mill with weak nitrate solution until a pulp is obtained of sufficient fineness (100 mesh) to permit it to be treated in a vacuum filter. The pulp is then heated up in order to cause solution of the nitrate contained in the solid and the hot pulp is filtered through a vacuum filter.

For this purpose the well-known and well-tried vacuum filters are used. The liquor which is withdrawn from the filter is sent to the main plant to be used as a feed liquor in the main operation, and the cakes are washed, first with a weak nitrate solution, and subsequently with a brine wash (the recovered washes being used in the cycle for the next treatment), the finished cakes being discharged practically barren of nitrate.

In the second of these methods the fines, without

grinding, are heated up with weak nitrate solution and filtered in pressure filters. The recovered liquor is sent as before to the main plant, the cakes being washed with weak nitrate solution, and finally with brine and discharged.

In the third the fines are treated with weak nitrate solution to complete the disintegration of the raw material, and the pulp obtained is classified in order to separate the slimes and fine sand (80 mesh). The remaining sands and stones are washed in a counter current system, being discharged with practically no nitrate content at all, while the slimes and fine sands are separated from the liquors obtained by vacuum or pressure filtration. The amount of solid filtered by this method is only about 20 per cent of the total insolubles and no grinding is necessary.

Whereas it is claimed in all three methods that complete lixiviation is procured and the refuse discharged with no nitrate contents at all, it is probable that costs of operation will be higher in the first and second methods than in the third method.

All these methods, however, leave this much to be desired. The proportion of fines which can be treated in the auxiliary plant is limited by the amount and ley of the cleaned coarse material sent to the main plant, because the auxiliary processes do not aim at the production of a directly crystallizable liquor, but only at one of such strength as can be sent to the main plant as a feed liquor.

If, as an example, 80 per cent of the nitrate in the raw material were contained in the fines the remaining 20 per cent in the coarse would not be sufficient to strengthen the liquors obtained from the auxiliary process unless such a process produced a correspondingly strong liquor. Of course, the removal of only a portion of the fines by screening, limits immediately the utility of the auxiliary processes by reducing the advantage gained in the main plant of treating cleaned coarse material.

The strength of liquor that can be obtained by the auxiliary treatment process is limited by many circumstances.

In the first case high temperature pulps (meaning high nitrate content of liquors) are not easy to handle, because of the tendency to rapid crystallization on the part of such liquors by cooling.

Secondly, the vacuum filter imposes a limit on the temperature of the liquor which can be passed through it and the pressure filter must be closely jacketed.

And lastly, if the pulp, after filtration and before washing, contains 30 per cent liquor content, which it is quite likely to do by vacuum or pressure filter, this liquor will hold as much or more nitrate in the cake as the dry fines had in them before treatment. This means that the actual extraction of nitrate from the fines will be done by the first wash, which must in that case be an absolute displacement of the strong liquor, as mixing during the wash would reduce the strength.

Assuming fines of 14 per cent nitrate content to be treated for production of a liquor of 750 gm. nitrate per liter (say, 50 per cent nitrate by weight):

100 lb. fines equal say 14 lb. nitrate,  
11 " salt,  
75 " insolubles,

i.e., 86 lb. cake forming insolubles.

Liquor content of cake in or on filter before washing equals, say 30 per cent.

Then total weight of cake =  $\frac{86}{70} \times 100 = 122.8$  lb.  
of which 86 lb. is insoluble 86.0  
36.8 lb.

This liquor being 50 per cent by weight of nitrate, there will remain in the cake 18.4 lb. nitrate. This excess over the 14 lb. nitrate originally present in the 100 lb. fines is taken from the extracting liquors. The wash must be a complete displacement wash or the 18.4 lb. nitrate will not be regained as liquor of 50 per cent strength.

Although there are limitations to the auxiliary processes of this kind themselves and to the use of them in connection with the main plant, they are being applied to the different plants at present in their limited capacity with very beneficial results.

The second class of auxiliary processes depends on the treatment of the refuse from the main plant by any of the three methods described above.

The whole of the refuse is ground in tube mills and either filtered or classified and partially filtered, with the result that the nitrate which would otherwise be discharged with the refuse on the dump tip is regained from it in the form of liquor which is used as a feed liquor in the main plant.

It will be obvious that the methods used in these auxiliary processes will be capable of application as a complete process, that is, one which will treat the whole of the raw material, if the liquors produced by them can be brought up to proper crystallizing strength by an efficient system of concentration and evaporation in the absence of being able to produce such liquors direct. It is claimed, however, that with the use of pressure filters such liquors can be easily obtained and the large-scale operations will prove later at what cost and what is the lowest ley of material which can be so treated.

An efficient process of evaporation would, however, make these auxiliary processes into complete ones and confer on them the ability to reduce the ley of the raw material to the minimum (thus reducing cost of mining considerably) by reducing the strength of the ultimate strength of solutions aimed at compatible with the costs of evaporation. In such an evaporation plant not only must the cost of evaporation be within commercial limits, but the design must be such as will efficiently cope with the greatest problem set before it in the handling of liquors which are below the saturation point for nitrate, viz., it must efficiently deal with the quantities of salt thrown out of solution during the evaporation. In working to the complete extraction of the nitrate contents of raw nitrate-bearing materials, not only will all the nitrate be dissolved, but also larger quantities of salt than heretofore, as well as the other soluble salts which may be present.

In concentrating the liquors obtained up to the necessary point to obtain crystallization of the nitrate contained, not only must the plant be capable of dealing with the salt thrown out of solution, and disposing of it free from nitrate, but it must be capable of producing so little mother liquor as to render easy the problem of disposing of the more soluble salts, such as calcium and magnesium chlorides and nitrates which would otherwise accumulate to the detriment of the process. Such a form of evaporator is now before the nitrate producers, and a plant capable of producing 2500 long tons per month is now being constructed in this country for delivery to Chile. The principles of this evaporation plant have been worked out in England on an experimental plant capable of producing 500 tons per month during a period extending over two and a half years, and in its present form it is confidently expected to reproduce the excellent results obtained in the trials and demonstrations carried out on the smaller scale.

In this type of plant, known as the Gibbs nitrate

evaporator, the above desiderata have been constantly borne in mind in addition to which continuity of operation has been sought for and arrived at.

The plant has been designed to act as a multiple effect evaporator, in the lower temperature effects of which part of the desalting is carried out, and in the final high temperature effect the temperature reached is so high as to practically complete the desalting. The desalted liquor is then crystallized by further evaporation in vacuum and the nitrate is regained as a continuous operation.

Special precautions have been incorporated in the design so as to prevent as much as possible incrustation of salts on the heating tubes, and also to provide for the settlement and removal of the deposited salt without interfering with the continuity of the operation.

The salt from each stage of the operation is washed and disposed of, and in the case of the salt separated at the high temperature it is collected and washed practically without loss of temperature, thereby preventing crystallization (and indirect loss) of nitrate with it. Wash liquors are returned to the evaporation system.

### Complete Processes

With the introduction of an ultimate system of evaporation such as is outlined above, considerable assistance may be rendered to the development of what has been described as the auxiliary processes. In conjunction with such a system they become complete processes, and no doubt as the costs of the operations such as are used by these auxiliary methods are properly elucidated and compared the cheapest and most efficient of them will be gradually adopted as standard.

The inventors of the evaporation plant referred to at present place their faith in the lixiviation process which, through classification and partial filtration, carried out at a tepid condition of temperature only, arrives at a complete extraction of the soluble contents of the raw material producing a liquor of about 30 per cent nitrate content by weight. This liquor is produced by the lixiviation of the raw material with water as the starting point and no return of liquors from the evaporation section is made.

The lixiviation section has under these circumstances the best possible chance of yielding the best results.

The evaporation section is quite separate from the lixiviation section, and as it only produces sufficient mother liquor to enable the crystal nitrate to be removed from the plant and dried in hydroextractors, this mother liquor is able to retain the more soluble salts together with the remaining sodium chloride, due to incomplete desalting. This mother liquor can be discharged from the cycle for purification periodically and sent back to the evaporation plant practically only carrying nitrate of soda. With such a complete process the cost of operation will be made up of cost of mining, cost of lixiviation, cost of evaporation, and these three factors can be adjusted to each type of material, depending on its original nitrate content and the strength of solution it is best to work for.

It is on these lines that the development of the refining of Chile saltpeter is taking place, and the ground is well prepared for such development.

Capital has interested itself in the newer ideas and objections to the introduction of completely new methods have died away or are slowly dying.

Rivalry between the workers on the development schemes on a healthy scale is assisting rather than hindering the progress, and from all points of view it must be agreed that a very bright future is assured to the Chilean industry from the results which will follow:



1. Increase in estimated life of properties.
2. Decrease in working costs.
3. Decrease in costs of newer installations.
4. Reduction of labor difficulties.
5. Increased control over methods of refining and mining.
6. Attraction of new capital and new blood to the industry due to its new activity and life.

### The Analysis of Light Oils

Contribution from the Havemeyer Chemical Laboratory,  
Columbia University No. 293.

By Gustav Egloff

The rapid, safe and accurate analysis of light oils resulting from the thermal decomposition of coal, shale or petroleum oil for their benzene, toluene and xylene content is of considerable industrial importance. In this communication a method is described which embodies the essentials of safety from fire, reasonable rapidity and a relatively high degree of accuracy. The still used consists essentially of an eight-foot column of foot lengths of iron pipe, with a reflux tube running below the distilling liquid in a copper flask of four liters capacity. The still was tested experimentally with varying percentage composition mixtures of benzene, toluene and xylenes. The concentration of benzene studied ranged between 2.0 to 80 per cent; the toluene between 3.0 and 90 per cent, and 6 to 58 per cent for the xylene concentration.

In addition to the determination of the accuracy of the still, an outline of the washing of a light oil free of olefins, neutralizing, steam distillation, drying and percentage composition of paraffins, benzene, toluene and xylenes (or solvent naphtha) present will be given.

#### DESCRIPTION OF STILL<sup>1</sup>

a. The column, eight feet in length, is made up of six sections of three-quarter inch pipe, one foot each in length, another eighteen inches in length, and one section of one and one-half inch pipe, six inches long. Each section is connected by means of a sleeve, and the last section with a three-quarter, one and one-half inch reducer. Between adjacent sections there is a 30-mesh iron gauze used as a diaphragm to support an eight-inch column of two-inch glass rods of one-eighth-inch diameter.

b. The reflux part of the column is made from one-quarter-inch pipe, and is six and one-half feet in length. It taps into the column six inches from the top, extends downward on the outside, and enters the column a

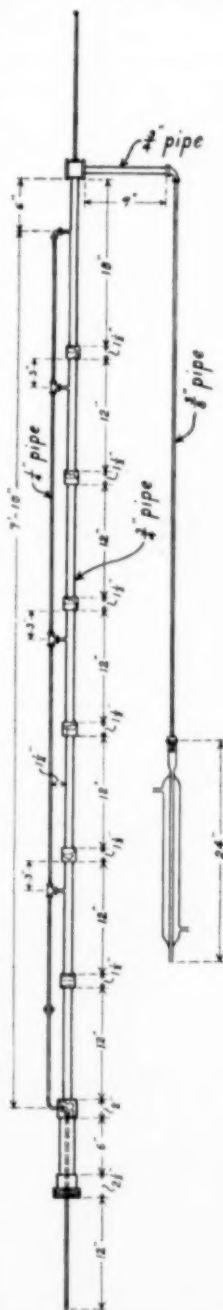


FIG. 1—STILL CONSTRUCTION

<sup>1</sup>Shown in Fig. 1.

foot from the bottom at the top of the one and one-half inch diameter section. It extends to within one inch of the bottom of the copper flask when the whole apparatus is connected. Three one-quarter inch elbows and tees, one one-quarter inch reducer union are used to make the fittings. Three one-quarter inch nipples tap into the three-quarter inch pipe, as shown in the drawing.

c. Attached to the top of the column is a tee which allows a thermometer to be inserted through one opening, and a three-quarter inch pipe in a horizontal direction, nine inches in length. At the end of this horizontal section is a reducing elbow of three-quarter one-half inch. A half inch pipe extends downward from this reducer, to a twenty-four inch condenser.

d. The connection between the column and the copper flask is made by means of a one and one-half inch Dart union, one section of which is connected to the bottom of the column, and the other to the neck of the flask.

e. The flask is made of copper with a capacity of 4000 c. c. It has a flat bottom of six inches diameter. To the neck, a one-one-half inch Dart union is brazed. The flask may be varied in size dependent upon the quantity of oil desired.

f. In order that the distillation may proceed evenly, it is best to surround the burners with a three-way asbestos screen to prevent drafts. It has also been found advisable to set the column in a box with a hinged door, which may be opened and shut at will. This door is closed at higher temperature distillations. This precaution is not necessary if the distillation is conducted in a room, which is free from drafts.

g. The manipulation of distillation is quite simple, although care must be exercised when first applying heat to the flask. If too much heat is applied the system floods. The reflux is not sufficient to carry off the column of liquid lifted by the supporting vapors. One can note the process of distillation by the temperature of the various sections of iron pipe, by simply touching. The rate of distillation is exceedingly important, for without this control a good separation is impossible. The work of Brown<sup>2</sup> has clearly emphasized the fact that the rate of distillation influences greatly the separation of mixtures. The data<sup>3</sup> in Table 1 show experimentally the wide differences resulting, when thirty, sixty or one-hundred and twenty drops per minute are used, in distilling a benzene and toluene mixture.

TABLE 1  
Mixture of Benzene and Toluene  
Number of Drops of Distillate  
per Minute

Temperature Range	Percentage Weight of Distillate		
	30	60	120
80.2-83.2°	0.8	0.6	0.6
83.2-86.2°	29.6	21.8	10.8
86.2-89.2°	9.8	14.3	20.2
89.2-92.2°	5.6	7.8	12.6
92.2-95.4°	3.8	5.0	7.0
95.4-98.5°	3.0	4.7	5.4
98.5-101.6°	2.8	4.0	5.0
101.6-104.6°	3.0	3.6	5.0
104.6-107.6°	4.3	5.2	5.6
107.6-110.0°	6.2	7.3	9.2
110.0-110.6°	11.6	9.8	11.1
Pure toluene by difference	19.5	15.9	7.6*
	100.0	100.0	100.0

\*Temperature barely reached 110.6°; residue not quite pure toluene.

In the present work two drops per second were found to be satisfactory. The two drops per second were checked by means of a metronome and stop watch. The end of the condenser was cut off square, so as to obviate constrictions, which would give a different size drop, hence affecting the rate of distillation.

Two thousand c. c. of mixtures of benzene, toluene and xylenes were distilled in each experiment. The

<sup>2</sup>Trans. Chem. Soc. 37, 49, 1880.

<sup>3</sup>Young's "Fractional Distillation."





Engler Distillation of Cuts

Per Cent by Volume	0-95 Deg. (Benzene Cut)		95-125 Deg. (Toluene Cut)	
	8' Column, Temp. Deg. C.	Hempel Column, Temp. Deg. C.	8' Column, Temp. Deg. C.	Hempel Column, Temp. Deg. C.
1st drop	79.9	78.8	107.3	101.2
2.5	80.9	80.3	108.7	104.9
5.0	81.2	80.9	109.0	105.5
95.0	90.4	92.0	122.4	124.3
97.5	99.7	101.0	128.9	129.0
Dry point	100.9	102.0	130.9	132.8
Distillation range	21.0	23.2	23.6	31.6

Residue		8' Column, Temp. Deg. C.	Hempel Column, Temp. Deg. C.
Per Cent by Vol.			
1st drop		133.0	130.8
2.5		133.5	132.3
5.0		134.0	132.9
95.0		138.5	138.3
97.5		138.9	138.5
Dry point		139.1	138.9
Distillation range		6.1	8.1

TABLE VI—PINTSCH HYDROCARBON OIL

	Percentage by Volume	Specific Gravity
Benzene	55	0.881
Toluene	8	0.871
Xylenes	37	0.869

Engler Distillation of Mixture of Benzene, Toluene and Xylenes

	Temperature, Deg. C.	Per Cent by Volume
First drop	84.9	0.0
To	90.0	7.4
	100.0	45.3
	110.0	63.8
	120.0	70.0
	130.0	77.8
	135.0	83.2
	139.2	Dry point

Distillation Results

Temp.	8' Column, Per Cent by Vol.	Sp. Gr.	Hempel Column, Per Cent by Vol.	Sp. Gr.
(Benzene Cut) 0-95°C.	54.9	0.881	54.4	0.880
(Toluene Cut) 95-125°C.	8.3	0.870	7.0	0.871
Residue	36.5	0.869	38.6	0.869
Loss	0.2		0.0	

Engler Distillation of Cuts

Per Cent by Volume	0-95 Deg. (Benzene Cut)		95-125 Deg. (Toluene Cut)	
	8' Column, Temp. Deg. C.	Hempel Column, Temp. Deg. C.	8' Column, Temp. Deg. C.	Hempel Column, Temp. Deg. C.
First drop	78.6	77.4	103.6	101.1
2.5	79.0	79.3	105.0	103.4
5.0	79.2	79.8	106.6	105.0
95.0	82.6	83.8	131.2	130.1
97.5	85.0	85.8	132.2	133.2
Dry point	90.0	93.0	135.0	134.5
Distillation range	11.4	15.6	31.4	33.4

Residue

Per Cent by Volume	8' Column, Temp. Deg. C.	Hempel Column, Temp. Deg. C.
First drop	131.0	130.1
2.5	132.0	131.4
5.0	132.5	131.9
95.0	137.0	137.9
97.5	137.6	138.0
Dry point	138.0	139.4
Distillation range	7.0	9.3

The analytical data in Tables IV, V, and VI represent mixtures of commercial concentrations from by-product coke-oven plants and the Pintsch gas process and are known as primary, secondary, and hydrocarbon oil. To compare the present single distillation method in an 8-ft. column, a standard Hempel column (shown in Fig. 2) was used with a flask of 500 c.c. capacity. The great advantages of the Hempel apparatus are efficiency, simplicity and ease of manipulation. But,

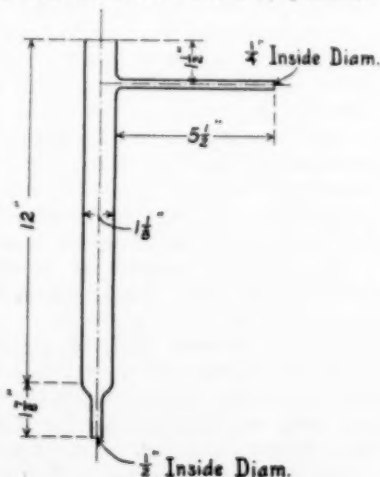


FIG. 2—HEMPEL COLUMN

three distillations are necessary when a Hempel column is used, as has already been shown in another communication.<sup>8</sup> To indicate the temperature range of the distillation of the fractions, a standard Engler flask of 200 c.c. capacity was used. The distillation was made in each case for each fraction using 100 c.c. samples of the benzene cut, to 95 deg. C., toluene cut 95 deg. to 125 deg. C., and the residue. The Engler distillation of the cuts gives important information as to the efficiency of the fractionation. The temperature range over which the cuts distil is given comparatively for the 8-ft. and Hempel column, in the following table:

	Temperature Range, Benzene Cut		Temperature Range, Toluene Cut		Temperature Range, Residue	
	8' Col., Deg. C.	Hempel, Deg. C.	8' Col., Deg. C.	Hempel, Deg. C.	8' Col., Deg. C.	Hempel, Deg. C.
Primary oil	8.1	12.0	20.2	22.0	6.1	9.0
Secondary oil	21.0	23.2	23.6	31.6	6.1	8.1
Hydrocarbon oil	11.4	15.6	31.4	33.4	7.0	9.3
Light oil from cracked petroleum	56.5	60.5	31.0	31.5	110.0	115.5

The temperature range at which the benzene, toluene and xylene cuts distil indicates quite clearly that a considerably better fractionation of the starting oil has been accomplished in one distillation with the 8-ft. column in comparison to three fractionations with the Hempel column.

TABLE VII

Light Oil from Cracked Petroleum  
Specific Gravity, 0.801 at 15.5 Deg. C.  
Engler Distillation of Original Oil.

	Temperature, Deg. C.	Percentage by Volume
First drop	42.5	0.0
To	50.0	0.8
	60.0	3.0
	70.0	7.5
	80.0	16.0
	90.0	26.0
	100.0	38.0
	110.0	50.0
	120.0	59.2
	130.0	66.2
	140.0	72.5
	150.0	76.1
	160.0	80.0
	170.0	82.1
	180.0	84.8
	190.0	86.4
	200.0	88.5
	210.0	90.0
	220.0	91.2
	230.0	92.5
	235.0	Dry Point

Distillation Results		8' Column, Per Cent by Vol.	Sp. Gr.	Hempel Column, Per Cent by Vol.	Sp. Gr.
Temperature					
(Benzene Cut) 0-95°C.		46.5	0.753	47.0	0.754
(Toluene Cut) 95-125°C.		23.2	0.821	23.6	0.821
Residue		28.5	0.858	27.5	0.859
Loss		1.8		1.9	

	Per Cent Benzene	Per Cent Toluene	Per Cent Xylenes
8' column	9.8	16.0	25.2
Hempel column	9.9	15.3	24.8

Engler Distillation of Cuts

Per Cent by Volume	0-95 Deg. (Benzene Cut)		95-125 Deg. (Toluene Cut)	
	8' Column, Temp. Deg. C.	Hempel Column, Temp. Deg. C.	8' Column, Temp. Deg. C.	Hempel Column, Temp. Deg. C.
First drop	41.5	42.5	105.0	104.5
2.5	48.0	51.5	106.0	106.8
5.0	52.0	54.3	106.5	107.0
95.0	86.0	95.0	124.8	127.0
97.5	90.0	96.0	130.5	132.0
Dry point	98.0	103.0	136.0	136.0
Distillation range	56.5	60.5	31.0	31.5

Residue

Per Cent by Volume	8' Column, Temp. Deg. C.	Hempel Column, Temp. Deg. C.
First drop	140.0	140.5
2.5	143.0	145.0
5.0	145.2	147.0
95.0	234.5	233.0
97.5	240.0	243.0
Dry point	250.0	256.0
Distillation range	110.0	115.5

The data in Table VII express the analytical results of the percentage composition of the benzene, toluene

<sup>8</sup>Rittman, Twomey and Egloff, This Journal, V. 13, p. 682, 1915.

and xylene in a light oil resulting from the thermal decomposition of a petroleum oil. The percentages of the aromatics present were calculated by means which are given in the following section. In analyzing the exceedingly complex mixture of a cracked petroleum light oil, where the olefin, paraffin, naphthene and aromatic hydrocarbons present, have similar boiling points, it is practically impossible to separate them by fractionation; hence the analytical results of the aromatic hydrocarbons present are very likely not accurate to closer than 5 per cent.

#### Method of Analysis for Light Oil

##### SPECIFIC GRAVITY

The specific gravity of the oil and of the distillates is determined by means of a Westphal balance at 15.5 deg. C.

##### OLEFINS

A sample of 2000 c.c. of the original oil is measured accurately in a graduated cylinder and transferred to a bell jar of 3000 c.c. to 4000 c.c. capacity, with a glass stop cock cemented in the lower part. Setting within the bell jar is a 1/4-in. diameter lead coil, for water circulation. A lead paddle wheel is utilized for stirring which can be run by a system of gearing from a small motor. A lead plate covers the bell jar through which suitable holes allow of the stirring device, cooling coil, and place for a 500 c.c. separatory funnel.

While the cooling water circulates through the lead coil and stirring goes on, 200 c.c. of 95 per cent C. P. sulphuric acid is run into the light oil at the rate of one drop per second or approximately 3 3/4 c.c. per minute. The deolefinizing of the 2000 c.c. sample requires one hour and twenty minutes or so.

After the addition of the 200 c.c. of 95 per cent sulphuric acid the system was allowed to stand for one-half hour, so as to give time for the two liquid layer systems to reach equilibrium. The acid layer which contains sulphonic acids of the olefin series hydrocarbons, and other complexes, is separated. After the removal of the acid sludge, the acid dissolved in the light oil is neutralized with a 6 per cent solution of caustic soda. The caustic soda solution and oil are stirred for fifteen minutes and allowed to stand for thirty minutes. The caustic soda sludge is then drawn off.

##### STEAM DISTILLATION

All the oil residue so obtained, freed from olefins as above, is now placed in a copper container of four liters capacity and distilled with live steam until the temperature reaches 180 deg. C., at which point practically all the light oil has distilled off. The condensed water is separated by means of a separatory funnel and the light oil thoroughly dried with fused calcium chloride. After drying, the oil is filtered free of calcium chloride. The dried oil is distilled by the method already given.

The distillate collected up to 95 deg. C., is the benzene fraction, that collected from 95 deg. C. to 125 deg. C. is the toluene fraction, and that collected from 125 deg. C. to 165 deg. C. is the solvent naphtha fraction. The volume of each of these fractions is carefully determined and the specific gravity of each fraction is taken at 15.5 deg. C. by means of a Westphal balance.

If the specific gravity of the benzene fraction is not below 0.880, that of the toluene fraction not below 0.871, and that of the solvent naphtha fraction not below 0.870, these fractions contain no paraffins, and their respective volumes represent the amounts of pure benzene, pure toluene and pure solvent naphtha in the 2000 c.c. of oil originally taken. If the specific gravities of the fractions are below the figures given, then paraffins are present and corresponding deduction must therefore be made.

##### PARAFFINS

A method of calculating the percentage of paraffins present in the benzene and toluene cuts is based upon the wide difference between the specific gravity of the paraffins and aromatics. The average specific gravity of the paraffin hydrocarbons to 95 deg. C. is 0.720 while the value for benzene is 0.881. For toluene the value is equal to 0.871 while the paraffins in this cut of 95 deg. C. to 125 deg. C. are equal to 0.730. The following numerical example will make the process of calculation clear.

Cut to 95 Deg. C.	
Specific gravity, paraffin hydrocarbons.....	0.720
Specific gravity, benzene.....	0.881
Specific gravity of cut to 95 deg. C.....	0.841
Subtract 0.720 deg. from 0.841 deg.....	12
Subtract 0.720 deg. from 0.881 deg.....	16

Assume that 75 c.c. collects in cut to 95 deg. C. — 12  
16

× 75 c.c. = 56.2 c.c.'s benzene in cut to 95 deg. C.

Since 2000 c.c. was used, the percentage of benzene in the sample is 2.8.

The quantity of paraffins contained in the several distillates is experimentally determined in the following way (which gives fair values of the percentage present).

Ten cubic centimeters (10 c.c.) of distillate are mixed with 25 c.c. of a mixture of two parts by volume of sulphuric acid (specific gravity 1.84) and one part by volume of 20 per cent oleum (fuming sulphuric acid). The mixture is thoroughly agitated in a 50-c.c. graduated cylinder with glass stopper and then allowed to settle.

Any paraffins present remain undissolved and their volume so determined divided by ten and multiplied by the total number of cubic centimeters in the particular distillate being examined gives the total volume of paraffins contained in said distillate. This quantity deducted from the total volume of distillate gives the net volume of distillate.

The percentage of benzene and toluene corrected for the paraffins if present in the light oil, are calculated as follows:

$$\text{Percentage of hydrocarbon} = \frac{\text{Corrected volume of fraction}}{2000} \times 100.$$

##### SPECIFICATIONS FOR BENZENE AND TOLUENE

In the use of benzene and toluene for the formation of phenol or picric acid and trinitrotoluene fairly rigid specifications are demanded as to their specific gravity, boiling points, color and sulphuric acid test. The following outline covers specifications which allow of their use for the above-named compounds, in the usual industrial operation.

##### Appearance:

(a) The toluene and benzene shall be water white in color and clear.

##### Specific Gravity:

(b) The specific gravity of toluene shall be between 0.869 and 0.872 at 15.5/15.5 deg. C.

The specific gravity of benzene shall be between 0.879 and 0.884 at 15.5/15.5 deg. C.

##### Boiling Point:

(c) The toluene shall boil within plus or minus 1 deg. C. of its boiling point of 110.0 deg. C. Of a 100 c.c. sample 90 per cent shall distil within 0.5 deg. C.; 95 per cent within 1.0 deg. C. The first drop shall not distil below 109.0 deg. C. and dry at 111.0 deg. C.

The benzene shall boil within plus or minus 1 deg. C. of its boiling point of 80.2 deg. C.; 95 per cent of its volume shall distil within 1.1 deg. C.



*Sulphuric Acid Test:*

(a) The toluene and benzene shall not impart more than a very faint straw color to sulphuric acid of 95 per cent concentration.

*Method of Testing:**Specific Gravity—*

(b) Determine by means of a Westphal balance, correct the result so as to compare the toluene at 15.5 deg. C. with water; also at 15.5 deg. C.

*Boiling Point:*

(c) Employ a 200-c.c. distillation flask with outlet tube  $1\frac{3}{4}$  above the bulb. Connect to a Liebig condenser about 24 in. long over-all with a straight condenser tube unstricted at the end. Place 100 c.c. of the sample of the toluene or benzene in the flask and adjust a thermometer graduated in tenths of a degree C. so that the top of the bulb is on a level with the side tube. Apply heat to a small area over the bottom of the flask and conduct the distillation in such a manner that the distillate passes over as quickly as possible in distinct drops. Collect distillate in a 100 c.c. graduated measure, read the temperatures at which (a) first drop of distillate falls from the end of condenser; (b) 2.5 c.c.; (c) 5 c.c.; (d) 9.5 c.c.; (e) 97.5 c.c. have collected. Finally record the temperature when the flask just becomes dry. Correct the readings for exposed mercury column and for barometric pressure. Allow 0.043 deg. C. per m.m. difference from normal atmosphere.

*Sulphuric Acid Test:*

(d) Shake for five minutes 50 c.c. toluene or benzene and 5 c.c. of 95 per cent sulphuric acid in a cylinder fitted with ground glass stopper. After settling, the color of the acid layer is observed. It should not be darker than pale, straw yellow.

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## The Determination of Zinc

By J. H. Hastings

Both the American Chemical Society<sup>1</sup> and the Australian Institute of Mining Engineers<sup>2</sup> have had committees working on the subject of a standard method for the determination of zinc in ores and each have recommended for adoption a different method than the one in common use by chemists and assayers in the West and to a somewhat more limited extent in the East. The former recommended Waring's method, slightly modified, and the latter the titration in an alkaline solution.

We are indebted to A. H. Low<sup>3</sup> for the general scheme of the titration of zinc in an acid solution as commonly used. I shall outline his method as modified for works' use, and for simplicity take for example an ore that is decomposed by nitric acid and potassium chlorate.

Weigh 0.5 gram into No. 2 (250 cc. capacity) beaker; add 0.5 gram potassium chlorate, cover with watch glass and add 10 cc. HNO<sub>3</sub>. Wait until first violent action ceases, a minute or two, place on hot plate or sand bath, and run to dryness slowly; have the beaker just hot enough so that the mass will froth up about one inch. When dry, tip up cover and catch drop against the side of beaker. Remove from heat. It is no advantage to leave the beaker on plate after the contents are dry, but rather is to be avoided, and take care not to allow the contents to fuse. This last precaution is taken to facilitate the later solution of the zinc. Cool, add 7 grams ammonium chloride, 20 cc. ammonia, 5 cc. bromine, water (the last for ores containing little or no manganese), and fill the beaker one-half full with hot water. Boil from four to six minutes at a moderate

heat. For ores containing much manganese, add 15 cc. bromine water at first and 10 cc. more after contents have boiled one or two minutes, still boiling the total time of from four to six minutes. Remove, filter through a No. 3 Munktell or similar filter paper into a No. 3 (350 cc. capacity) beaker, washing off cover and down sides of beaker with hot water. In filtering pour on the side of filter paper to avoid spattering and have the stem of the funnel against the filtrate beaker, so that the liquid will run down the side and not just drop into the liquid already in the beaker and spatter out, causing loss of zinc solution. Wash out beaker and wash precipitate ten to twelve times with the wash solution made by dissolving 100 grams ammonium chloride in hot water, adding 50 cc. ammonia and making up to one liter.

Add a couple drops of saturated solution of methyl orange solution, neutralize with hydrochloric acid and add 5 cc. excess. The volume should now be 200 cc., and with some practice the washings can be gauged so that this will be the case.

Heat to boiling, add 50 cc. saturated H<sub>2</sub>S water, and titrate slowly, stirring briskly, using 5 per cent solution uranium nitrate for indicator. It is best to work with a reserve portion, say 20 cc., and add portions of it until the final end point is reached.

Oxidized ores may be treated with 10 cc. hydrochloric acid, evaporated to a few cc., but not far enough for any part of the bottom of the beaker to be dry, as this condition may result in loss of zinc through volatilization. The acid should not boil.

To standardize, weigh out the same amount of zinc as the ore contains, so that the titration will be within 10 cc. of the number cc. the titration of the ore will require. The metallic zinc used should be specified for standardizing and marked with the analysis of the manufacturer.

### GENERAL DISCUSSION

**Decomposition:** The safest manner to decompose sulphide zinc ore is with the 5 gram potassium chlorate and 10 cc. nitric acid. This procedure results in partial precipitation of the manganese and makes a good body from which the zinc can subsequently be extracted without any trouble. The precipitation of the iron and manganese and partial extraction of the zinc in the manner indicated is quite efficient, but the zinc remaining in the iron precipitate must be extracted. This zinc is more or less insoluble in a solution of ammonium chloride, weaker than 10 per cent.

As to redissolving this precipitate and reprecipitating, much less of the zinc will be carried down the second time, and possibly with a third precipitation the zinc could be entirely extracted, at least with the limitations of the analysis. I have heard of six such precipitations being made. The chance for loss is apparent. One chemist told me that he had made three such precipitations in a determination on an ore which he thought contained manganese and he was laboring under the delusion that this procedure would separate the manganese from the zinc, when, as a matter of fact, it hinders that separation to redissolve this precipitate, as some manganese has already been precipitated by the chlorate and nitric acid. At any rate it was quite evident that the ore in question contained no manganese, as this metal, if in appreciable quantity (enough to effect the zinc determination), is shown by the brownish color of the mass on the first evaporation and the residue on this ore was pure white.

Another method of extracting the zinc from the iron precipitate is to add 50 c.c. alkaline, 10 per cent ammonium chloride solution and boil. It is a hard matter to thoroughly extract the zinc in this manner, as some of the zinc is apt to reprecipitate as the boiling continues and there is a state of equilibrium reached when

<sup>1</sup>J. Am. Chem. Soc. 1907-29-285.

<sup>2</sup>Proceedings—1913-10.

<sup>3</sup>Methods of ore analysis, 1913, Chp. XXX, p. 284.

while some zinc is dissolving some zinc is reprecipitating, and besides if all the zinc is dissolved the next procedure in this modification is washing four to six times with hot water, in which case some of the zinc is likely to reprecipitate on the filter upon dilution with water. This is an explanation, I believe, of why some results are low on ore running from 40 to 50 per cent zinc and 8 to 10 per cent iron.

The process of washing is very important, and it is unfortunate that analysts are, as a rule, untrained in this phase of chemical manipulation. There are certain ores on which it is difficult to extract the zinc from the iron precipitate. For instance, an ore running 16 per cent zinc and 30 per cent iron, or one containing 43 per cent zinc and 15 per cent iron, I have found difficult, and to require twelve washings instead of ten.

To wash the precipitation, have the extraction solution nearly boiling. On the first washing, start at the rim of the filter paper and wash around a couple of times, descending to the point of the filter. On subsequent washings wash down the point of the filter, stirring the iron precipitate well, say, the lower inch of the filter; then, still washing, circle around the filter paper with wash stream, gradually working up to the rim of the paper, and then around down to the vortex again, giving the iron precipitate a final churn with the stream. This leaves about an inch of liquid, measured up the side of the paper, in the filter. Keep blowing just hard enough so that the stream will not break the filter paper, but blow as hard as the filter paper will stand. The volume of the filtrate will be about 200 to 225 c.c. This makes about 12 to 13 c.c. for each washing. Several small washings are more effective than a few large ones.<sup>4</sup>

Neutralizing should be done carefully and exactly 5 c.c. hydrochloric acid added in excess as the uranium ferrocyanide is slightly soluble in hydrochloric acid, depending on the strength.<sup>5</sup>

The beaker is covered, set on a warm place until ready to titrate, then brought to a boil and the 50 c.c. hydrogen sulphide water added. It is not necessary to boil out the bromine, but it does no harm to do so.

The titration is perhaps the most difficult part of the whole determination to master. In the first place, provided the solution has been standardized correctly, it is not likely for one to get low results through faulty titration. But, on the other hand, it is a simple matter to be too high. We will assume that the standard solution is correct; then for a novice to hope to be correct in his results he must bear in mind several things. One of the first is to have a saturated hydrogen sulphide solution in an amber-colored stoppered bottle.

Have this solution strong enough so that you cannot stand more than one strong sniff of it. Add 50 c.c. to the zinc solution, stir well for several seconds. Pour off, say, 20 c.c. Run in the standard solution slowly, stirring vigorously, until after testing from time to time the end point is reached. The zinc solution generally turns milky at this stage, but it takes some experience to be able to note this change. Then add half the 20 c.c. and again titrate to an end point, repeat with half the remaining 10 c.c., then run very carefully until the end point is again reached and put in final 5 c.c., and finish the titration. When the last 5 c.c. are emptied into the main beaker the solution is poured back into the first beaker. Repeat to rinse the reserve beaker. The proper way to stir the solution is to stir once around about half way down between the center and sides of the beaker; then reverse and

stir back to the starting place. Repeat this operation about three times, then stir from one side of the beaker to the other through the center, repeating this procedure three times. This is the general idea of thoroughly churning up the liquid with little danger of splashing any out of the beaker. I might say that the stirring cannot be done effectively with a glass rod, but it is better to use a hard rubber rod with a soft rubber tip, so as to avoid breaking the beaker.

The end point is the first faint change to a reddish color. A "fake end" point sometimes shows up, especially if the titration is carried on rapidly. This sometimes shows up as early as 10 c.c. before the true end point, but can be detected by the fact that it does not get deeper in color if more ferrocyanide solution is added.

A turning green of the solution can be accounted for either by the decomposition of the potassium ferrocyanide through the presence of an oxidizing agent, and in this case the hydrogen sulphide water is not strong enough to do its part and should be strengthened by bubbling more gas through it. The other cause for a green color is the presence of iron, which has gotten in the solution through contamination. This sometimes can be traced to the hydrogen sulphide water, too, as often the wash water for the gas generator bubbles over into the receiving bottle or iron may run through or over the edge of the filter paper in filtering, and thus gets into the filtrate.

Too high results are more apt to be obtained on high titrations over 40 per cent than on lower ones, due to an accumulative error because of titrating too rapidly.

For titrating the volume of the solution should always be the same. This is important, as well as the acidity and the amount of salts in solution. Use the same size drop, both of the indicator and the solution to be titrated, retaining the same conditions of spotting on the ore as were used on the standard.

There is one criticism I should like to make of the scheme given by Low,<sup>6</sup> and that is in regard to standardizing. Low does not allow for the same amount of salts in solution in the standard as for the ore, and consequently, on 40 c.c., the standard runs 0.7 c.c. higher than if it was run through like the ore, thus making the determination of zinc 0.7 per cent too low in this particular case.

The standard solution contains 21.54 grams potassium ferrocyanide per liter, and 1 c.c. equals 0.005 gram of zinc or 1 c.c. equals 1 per cent on a 0.5-gram weighing.

The equation for the precipitation in an acid solution is evidently different from that in an alkaline solution, for the latter standard solution requires 16.25 grams potassium ferrocyanide per liter. The reason being that in an acid solution the precipitation is a potassium zinc ferrocyanide and in the latter a normal zinc ferrocyanide.

The method adopted by the American Chemical Society is as accurate as the one described, but not so simple or convenient in the manipulation. In the alkaline titration analysts have experienced trouble in getting a definite end point on the standard which holds good for the subsequent titration of the ore analyses. One scheme described even going so far as to insist on a standard being run with each set of twelve determinations, since the end point varied with the eight. Using Low's method there is no such trouble with the end point if a 5 per cent uranium nitrate solution is used, kept in an amber-colored glass bottle.

In the use of a method for determining zinc in an acid solution without the addition of hydrogen sulphide

<sup>4</sup>Ostwald's Scientific Foundations of Analytical Chemistry, 1895, Chap. Page 18.

<sup>5</sup>Miller, Chemical Analysis, 1904, Chap. IX, page 67.

<sup>6</sup>Methods of Ore Analysis, 1913. Chap. XXX, page 284.



water before titration, the chlorine apt to be produced gives high results.

Of the metals that interfere, manganese has been accounted for; copper is precipitated by the hydrogen sulphide water. Small amounts of cadmium are not precipitated by the latter. On a standard made up of 200 grams zinc and 0.015 gram cadmium sulphide, the result was 0.22 c.c. too high, equivalent to titrating an ore running 40 per cent zinc and about 2 per cent cadmium. Cobalt and nickel interfere, but are not found in the ordinary zinc ores of commerce. Acknowledgement is due Mr. J. W. Richards of Denver for many helpful suggestions.

Donora Zinc Works,  
Donora, Pa.

## Hydro-Electric Power and Electrochemistry and Electrometallurgy in France

By C. O. Mailloux, E. E., D. Sc.

(Member of the American Industrial Commission to France).

(This article contains the notes which were prepared by Dr. Mailloux to furnish information for the editors of the Report of the American Industrial Commission to France. A brief abstract of the first portion only, relative to hydroelectric power, was published in the Report. The second portion, relating to Electrochemistry and Electrometallurgy, has not yet appeared in print. The present installment contains the complete text of the first portion, and the complete text of the second portion will appear in a subsequent issue.—Editor.)

There is abundant evidence that the importance and value of hydro-electric power (the power generated by water and transmitted to and distributed at distant points by electricity) are thoroughly understood and appreciated in France. There is, indeed, no country in the world today where steps have been taken for such a comprehensive and exhaustive study of all the water powers available in the various parts of the country. This makes a somewhat detailed reference to the subject of considerable interest.

The art of utilizing water power and of transmitting energy to long distances by electricity is one in which France was a pioneer and a leader, and in whose development she has taken and is still taking an important part.

On the one hand, the possibility of obtaining power from the energy available in the water of mountain streams is of great interest to a country which, like France, produces only a portion of the fuel it consumes, and has to supplement its own production by importing large quantities of coal from other countries. Before the war the annual coal consumption in France was, in round numbers, 60,000,000 tons, of which amount about 40,000,000 tons were obtained from French coal mines, leaving a shortage of about 20,000,000 tons to be made up by importation from other countries.

On the other hand, there are numerous places where water power can be developed in considerable amounts in the mountainous regions of France, in the Northern and Southern French Alps, in the Vosges and Jura Mountains, and in the Pyrenees. The aggregate of this power is estimated at from 6,000,000 to 10,000,000 hp.

It is estimated, from statistics in regard to steam power in France, that about 75 per cent of the total coal consumed, or about 45,000,000 tons, is used for producing steam for generating mechanical power, aggregating about 12,000,000 hp. This corresponds to about 3,750,000 tons of coal per year for each million hp. of steam power capacity, so that the full development and utilization of 6,000,000 hp. of water power would, theoretically, more than make up for the entire coal shortage in the whole country.

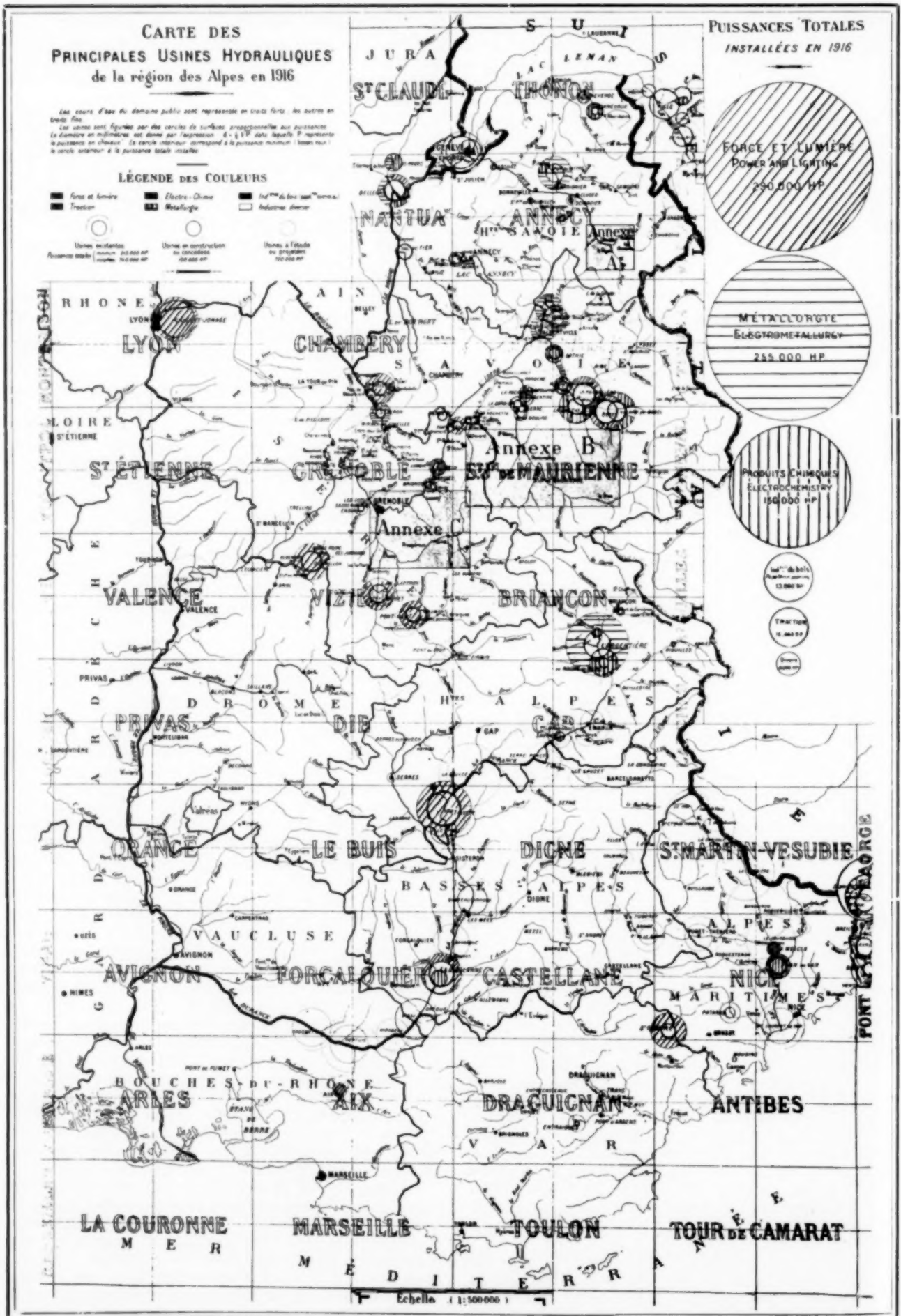
The American Industrial Commission to France had the privilege of visiting the very interesting region where water power abounds—the so-called "white coal region" ("région de la houille blanche")—in the eastern

part of France, on the western slopes and watersheds of the Alps, and the Jura Mountains, where French scientists and engineers found both the incentive and the opportunity for the wonderful pioneer work done by them in hydro-electric power development and power transmission.

*Evolution of Water Power.* Before 1827 the only forms of water motor in general use in the world were the old-fashioned "waterwheels," now of historic or pictorial interest only, and seldom to be seen elsewhere than at some old-time grist-mill or in some picture of by-gone periods. These waterwheels were of small power capacity, in spite of their large size; they were not at all suited for the development of power in great amount from large and high water falls. There was a limit not only to the diameter that could be given to them, to adapt them to falls of greater height, but also to the length that could be given them, to adapt them to an increased volume of water from large streams. An idea of the inherent limitations thus imposed on the power capacity attainable with waterwheels of that now obsolete kind may be obtained from the best examples of such wheels, such as from the four remarkable breast-wheels, each 50 ft. in diameter, said to be the largest in the world, erected at Catrine in Ayrshire, Scotland, by Sir W. Fairbairn in 1825. These monster wheels, a monument to the boldness of their designer, are still working; but as the capacity of each is only 125 hp., there is no likelihood of their serving as models for modern water motors. More than 1000 times that power capacity can now easily be put into the same space with a modern water motor.

The efforts made to devise a water motor more satisfactory than the old-fashioned waterwheel date from the year 1827, when a prize was offered, in France, by the Société d'Encouragement for an improved water motor. The modern type of water motor known as the "turbine" owes both its origin and its name to that offer. The prize was awarded to Fourneyron for his celebrated water motor, the first hydraulic "turbine." The wonderful perfection of this invention is sufficiently shown by the fact that the Fourneyron turbine is still being made extensively today, with but little modification in design. Moreover, Fourneyron had made such important contributions to the problem of securing proper speed regulation and high efficiency at varying loads and with varying amounts of available water that most of his methods and expedients for attaining these objects are still utilized in many cases.

Fourneyron's invention led to a rapid development in water motors of the turbine type, as the result of which it became possible to produce water motors of greatly increased power capacity, occupying much less space, and, especially, to use such motors for developing power from water falls of much greater heights and volumes than had been hitherto possible. The development of turbines suitable for producing large amounts of power, especially from high waterfalls, however, was slow. The reason is that for more than 50 years after the advent of the turbine there was little, if any, demand for such turbines. During all that time the only method of power transmission known to the world was that of mechanical transmission by means of shafting and belting, to very limited distances, and in limited amounts. Under such circumstances it was necessary either that the power should be developed very near the works where it was utilized, or else that the works should be located very near the place where the power was to be developed. In most cases turbines of large power and suitable for high heads were not necessary. It was more practical to use a greater number of smaller turbines. In the majority of cases no attempt was made to utilize either the full flow or the full head of the



MAP OF FRENCH WATERPOWERS



stream. The result was that usually a great portion, often the greater portion, of the available power was not utilized.

As is well known, it was only after the advent of electric power transmission that there arose a demand for large prime movers for both water and steam power. Even as late as 1875 a hydraulic turbine or a steam engine of 300 or 400 hp. was considered a very large power unit. It is noteworthy that one of the "world wonders" at the Centennial Exposition in Philadelphia in 1876 was a pumping engine of 1000 hp., designed by Corliss, the great American engine builder. At that time this was considered, even by engineers, a unit too large to be practical. Even in spite of the advent of the direct-coupled engine-driven dynamo, which made a demand for larger steam engines, the largest unit at the Chicago Exposition in 1893, or seventeen years later, was barely 1000 hp. At the present time hydraulic turbines of 20,000 hp. and steam turbines of 75,000 hp. are no longer considered marvellous.

The highest development and the most important applications of hydro-electric power generation and transmission have resulted from progress in two important respects, namely, increase in the height or head of waterfall utilized for producing power, and increase in the electrical pressure or voltage utilized on the electrical transmission line. It is worthy of note here that these two features were first suggested and tried in France, in the very region visited by the commission.

**High Head Hydraulic Turbine.** Efforts to develop the hydraulic turbine in order to adapt it to very high heads were made by the original inventor himself, Fourneyron, as early as 1840, and again, later, in 1850, by another prominent French hydraulic engineer, Gérard, the inventor of the turbine of that name. The highest falls to which these men attempted to adapt turbines are said to have been of "over 100 meters" (328 ft.). The practical results do not appear, however, to have been entirely satisfactory. It was recognized that the hydraulic turbine would need to depart considerably from the standard types of Fourneyron and Gérard, in order to meet the requirements for high heads. The "reaction" type of turbine had been highly developed; but the "impulse" type needed further development. This was also realized in America, especially in mining work, where it is desirable to utilize streams of small flow and of high heads as sources of power. Attempts to solve the problem of obtaining power from waterfalls of high heads were made in America in the mining districts in California, beginning about 1860, which resulted in the construction of primitive "impulse wheels," known as "hurdy-gurdy wheels," carrying vanes against which jets of water were directed. The evolution of this "hurdy-gurdy" water motor led, in time, to the invention of the Pelton wheel. Some of these "hurdy-gurdies" were used with heads as high as 2100 ft. (640 meters). No attempt seems to have been made, however, to produce large power units, the largest sizes used being of only 100 to 125 hp.

A most interesting contribution to the evolution of the turbine was the invention, in 1867, of a new, highly practical and efficient form of "impulse turbine" by M. Aristide Bergès, a French engineer, proprietor of a large factory devoted to the manufacture of paper and woodpulp, located at Lancey (Department of Isère) near Grenoble.

M. Bergès in 1867 attacked the problem of utilizing the power obtainable from a nearby waterfall of 200 meters (656 ft.) as a source of mechanical power for his woodpulp works. His experiments and tests led him to design and construct a turbine of entirely new and very original type, which was put in permanent opera-

tion, giving satisfactory service, in 1869. This turbine, which is now preserved in a museum at Lancey, furnished power for grinding wood to make woodpulp fibre. It utilized the full head of the fall (200 meters, or 656 ft.). In 1873, after this turbine had been giving satisfactory results for four years, M. Bergès installed a second turbine, designed to utilize the water from a fall of 500 meters (1640 ft.). This turbine was remarkable, not only for the high head under which it could operate, but for the great power that it could develop (800 hp.), which entitles it, perhaps, to rank among the largest hydraulic turbines of that period. It was moreover remarkable, in fact epoch making in still one more respect, namely, that, as a hydraulic turbine of the "impulse" type, its design, construction and operation embodied substantially the same principles as appeared from twenty to twenty-five years later in the steam turbine of the "impulse" type; so that a person skilled in the art of designing steam prime movers, and properly informed in regard to the difference in physical properties and characteristics of the two "fluids" used, namely, water and steam, should have been able to evolve a satisfactory type and form of steam turbine from the Bergès hydraulic turbine. In the next few years other turbines were installed at the paper works, until the stream utilized, a small mountain brook, coming down from the glacier, which originally supplied only a nominal amount of power (not over 50 hp.), was supplying 2000 hp. to the works, besides furnishing power for generating electric current used for lighting in the surrounding villages. M. Bergès estimated, at the time, that the power made available by his efforts (about 3000 hp.) could be practically trebled by developing power higher up on the stream, so as to utilize the entire head. This more complete development of the stream is now in process of being carried out; so that M. Bergès's dreams of power development in Lancey and vicinity are coming true. At the 1889 exposition in Paris, M. Bergès exhibited one of the early turbines made by him, and he announced the fact that he was at that time designing a turbine equipment for developing power from a fall of 1718 meters (5635 ft.). This is perhaps the highest head that has been proposed for utilization by means of any form of water motor. A "tour de force" of this character was not an impossibility with the Bergès type of "impulse" turbine.

The American Commission visited the Bergès Works at Lancey by invitation, and saw several Bergès turbines in operation, including one installed over 40 years ago, which was still doing satisfactory service.

**High-Voltage Electric Transmission.** It happened that the vicinity of Grenoble was the scene of the first scientifically conducted tests of long-distance electric power-transmission. Those tests, which were made at different periods between 1880 and 1883, were conducted by an eminent French physicist and engineer, M. Marcel Deprez, for a syndicate of French capitalists. Their purpose was to determine, by practical trial, under diversified conditions, the amount of power which could be transmitted, the losses of transmission, the limitations as to distance and commercial feasibility, and, incidentally, to find ways of improving the apparatus used and the results obtained. The transmission line used extended from Grenoble to Vizille, a distance of about 20 kilometers. By making loops and detours in the line the transmission-distance could be increased to 50 kilometers or more.

These tests were epoch-making in many respects, but their greatest value was in demonstrating the importance of high voltage as a factor of economy and of commercial success in electric power-transmission. They pointed out the direction in which improvements

in methods and in apparatus must be sought in order to make success possible.

**Distribution-System.** While economy of transmission dictated the use of the highest possible voltage on the transmission-lines, the conditions attending the distribution of electric power at the receiving end of the transmission-line, and the necessity of avoiding all danger of harm to persons and property, introduced new problems, calling for means of reducing the voltage of the electric current "distributed" to the consumers. This was furnished by the development of the "transformer" during the last decade of the nineteenth century. This period marks the beginning of the rapid development of hydro-electric power in all parts of the world.

**"White Coal."** The term "houille blanche," meaning literally "white coal," for designating the power obtainable from the melting ice and snows of glaciers, is said to have originated with Cavour, the Italian statesman, but it was introduced and made popular in France by M. Bergès, the inventor of the high-head hydraulic turbine. He originally employed this term to designate all streams which are fed and regulated by glaciers, because the solidified water in the form of ice and snow in this glacier represents stored energy available for power, similar to the stored energy contained in ordinary ("black") coal. The energy available in streams not fed by glaciers was termed "green" coal ("houille verte"), because the energy comes from water stored in green vegetation. The expression "white coal" has, however, gradually enlarged its meaning, and it now means the energy of any water-fall that is available for developing water-power; therefore it now practically includes "green" as well as "white" coal, although the term "green coal" is still occasionally used.

**"White Coal" Congresses.** In September, 1902, a "white coal" or water-power congress was held at Grenoble, which was a great success. From statistics presented at that congress it appeared that the water-power already developed at that time, in France, aggregated about 200,000 hp. With a view to stimulating the development of water-power in all parts of France a resolution was adopted, requesting the Government to take steps to make a survey of the available water-power of France. In 1903 the Government took action by creating a commission for large water-powers, which was entrusted with the work of estimating the hydraulic resources of France. This commission has already studied a certain number of the basins in the Alps and in the Pyrenees, from the geographical, meteorological and hydrographic points of view. The results of these researches are published regularly. Six volumes have already appeared for the Alps and two for the Pyrenees. The commission has also published some very useful maps, giving information and data regarding the hydro-electric plants in the region of the Alps. One of these maps gives the locations of electric generating plants and the transmission and distribution systems up to 1912; another map, just issued (1916), gives the fullest and most recent information about the location and capacity of the principal water-powers and the work for which the power is used in the region of the Alps. (See map, page 266).

A second water-power congress, organized by an association of water-power owners, was to have been held at Lyon in September, 1914. It was, of course, postponed. It will likely be held soon after the war is over. The rapid development of water-power in France will doubtless make these congresses recur at shorter intervals in the future.

**Water-Power Association.** As in the case of all large industries in France, the water-power industry has its

interests looked after by a "get-together" organization, having a very comprehensive name, which includes all concerns interested in water-power, electrometallurgy, electrochemistry and "all the industries related thereto." The association is really composed of three distinct groups of industries, each of which has its council or board of directors; the first group, composed of concerns engaged in "electric power transmission and distribution," contains 54 member-companies; the second group, composed of concerns engaged in "electrometallurgy and electrochemistry," contains 24 member-companies; the third group, composed of "sundry and miscellaneous concerns," contains 30 member-companies. There is a general council, of not less than 12 nor more than 35 members, elected at the annual meeting from representatives of all three groups of member-companies. Continuity of policy in the council is secured by electing the members of the council for three years and changing only one-third of the total number each year. The council members elected from each group of member-companies also form, by themselves, a corresponding "section" of the council. Each of the three sections of the council must meet at least six times each year to consider matters of special interest or importance to that section. Its decisions and resolutions are subject to approval and review by the general council. The statutes (by-laws) of the association are similar to those of other French industrial associations or syndicates. They are a model of their kind. A practical means of securing co-operation and exchange of information and ideas between this and other similar industrial associations is to have the same person serve them all in the capacity of general secretary. His office is the information bureau for all the associations and their various sections, and he is the connecting link between them all. They all have their headquarters and hold all their meetings at the same place. Their co-ordination is remarkably complete and perfect, and they can co-operate for accomplishing a common object, on occasion, in a most prompt and efficient manner.

**Available Water-Power.** The work done by the Water-Power Commission, since it was organized in May, 1903, enables a fairly close estimate to be made of the water-power available in the region of the Alps, but it is still difficult to make any estimate of the water-power available in the rest of France. An official estimate made under the direction of the Water-Power Commission five or six years ago gives the following approximate figures:

	Low Water Flow, H.P.	Average Water Flow, H.P.
Northern Alps (Haute Savoie, Savoie Isere, Hautes Alps) .....	1,000,000	2,000,000
Southern Alps .....	1,300,000	2,600,000
Central Alps, Vosges and Jura Mountains ..	900,000	1,800,000
Pyrenees and elsewhere .....	1,400,000	2,800,000
Total .....	4,600,000	9,200,000
Another, more conservative, estimate gives an aggregate of 4,500,000 hp. for low water, and 6,000,000 hp. for mean water.		

**Capacity Developed.** The official annual (1914-1916) report of the French Water-Power Association, already mentioned, states that the aggregate power-capacity of all the water-powers owned or exploited by the various power companies belonging to that association is 660,000 hp.. Of this total, 412,000 hp. represents power transmitted and distributed for general lighting and power purposes in cities, towns and villages; the rest (248,000 hp.) is power consumed by electrometallurgical and electrochemical industries. The distribution-systems owned by the power companies belonging to the association constitute a network of 16,200 kilometers (10,066 miles), of which 13,400 kilometers (8325 miles) are overhead lines and the rest (2800 kilometers, or 1740 miles) are underground lines. These distribution-



systems serve to supply electric current for light and power to communities aggregating between four and a half and five millions of inhabitants.

The capital investment represented by all these plants exceeds 600,000,000 francs.

The greater number of these plants are located in the region of the Alps. As there are also many water-powers, both in the Alps and elsewhere, which are operated by companies and individuals who are not members of the Water-Power Association, the preceding figures for power developed are presumably too low for the whole of France. According to statistics prepared by the French Water-Power Commission, the total installed power-capacity in the eastern regions alone exceeds the total given above. The official figures, for Dec. 31, 1915, as reported by the commission to the Government, show the following results:

Hydraulic Power-Capacity Installed in the Region of the Alps

	H.P.	% of Total
Power used for light and power.....	291,000	39.4
Power used for electrometallurgical works.....	255,000	34.6
Power used for electrochemical works.....	147,000	19.9
Power used for electric traction.....	16,000	2.2
Power used for paper mills, saw mills, etc.....	23,000	3.1
Power used for various industries (lime and cement works, spinning, etc.).....	6,000	0.8
Total .....	738,000	100.0

These figures agree substantially with those given on the map issued, as already stated, in 1916, by the Water-Power Commission.

Of the above total, the basin of the Isère River furnishes 427,000 hp. and the basin of the Durance River furnishes 112,000 hp., the rest (199,000 hp.) being furnished by the basins of the Rhone and other streams.

The 1916 map gives the following additional information for the same region:

Power-plants under construction or for which contracts have been made..... 100,000 hp.  
Water-powers whose development is contemplated or proposed..... 700,000 hp.

The American commission saw evidence of great activity in further developments of water-power, many of them of considerable magnitude and importance, at various points in the "white coal" district. The members were given the opportunity to see several power-sites where the construction of dams, intake and discharge canals, power-station buildings, transmission-lines, etc., were under construction.

In addition to the projects now in process of realization there are many more that are in contemplation for the future. The pioneer work of Bergés has borne fruit in the development of the impulse turbine for high heads, and of large power-capacity. There is no longer any hesitation to utilize falls of 1000 to 2000 meters (3280 to 6560 ft.) in height, in one station, instead of doing it in a number of steps or stages, with a dam and a power-station at each stage, in order to reduce the working head and pressure at each stage, and turbines of 10,000 to 20,000 hp. are coming into use. The highest fall developed in France up to the present is at Orlu on the Argege River, where the fall is 940 meters (2983 ft.).

The two most important water-power projects are those known as the "Durance" and the "Upper Rhone" projects.

**Durance Project.** This project is aimed at the utilization of the water of the Durance River in the south-eastern part of France, at a point about 200 kilometers (124 miles) from Marseilles. The project is in the hands of a syndicate known as the "Société pour la régularisation de la Durance," composed largely of people who are already interested in many of the large water-power companies owning plants in the region of

the Alps. The head of the syndicate is the managing director of the companies already owning and operating the largest water-powers in that region, including one on the Upper Durance of 30,000 hp. and one in the Mediterranean Coast region of 32,000 hp., and he is a director in seven other companies operating smaller plants, the aggregate of all the plants being a power-capacity of over 110,000 hp., representing a capital investment of over 140,000,000 francs. From this it will be seen that the Durance project is in the hands of competent, experienced persons. The dam will be located at Serre-Ponçon. It will have a height of 85 meters (279 ft.) above mean low water, and of 127 meters (417 ft.) above the rock-foundation. The storage-reservoir produced by this dam will hold 600,000,000 cubic meters of water. This will enable the flow of water below the dam to be regulated so as to secure minimum steady flow at the following rates:

During six autumn and winter months, 50 cubic meters (13,210 gal. per second).

During three spring months, 65 cubic meters (17,173 gal. per second).

During three summer months, 75 cubic meters (19,815 gal. per second).

The power available with these quantities of water will range from about 70,000 hp. in summer down to somewhat less than 50,000 hp. in winter. The power-station, which will be installed near the dam, will comprise eight units of 10,000 hp. each. The greater portion of this power will be utilized for electrochemical products, especially for making cyanamide and other nitrogenous substances, and also for electrometallurgy. The estimated cost of this power-development is 36,000,000 francs.

**Upper Rhone Project.** The Rhone is the outlet of Lake Lemman (sometimes called the "Lake of Geneva"), which constitutes an enormous storage reservoir for that river. In the Swiss portion of the Upper Rhone, extending from Geneva to the French frontier, a distance of about 18 kilometers (11 miles), the city of Geneva itself has been active in developing water-power. It began as far back as 1713, when the hydraulic power of the Rhone was utilized to furnish power for pumping water for the city of Geneva. The old water-pumping station, after undergoing innumerable repairs, extensions and improvements, during a period of nearly two centuries, was finally replaced by a new, modern water-pumping station, begun in 1883, and finished in 1887, which was, and remains, the model of its kind. The world-wide interest excited by this plant was largely responsible for the appointment of its designer, the late M. Turettini, later Mayor and Commissioner of Public Works of the City of Geneva, as one of the members of the commission of eminent scientists and engineers that outlined the plans for water-power development at Niagara Falls.

The dam serving for this pumping-plant also serves for the very important purpose of regulating the flow of water from Lake Lemman into the Rhone, so as to keep the level of that lake within certain limits, the extreme variation allowed at any time between highest and lowest levels being only 60 centimeters (about 2 ft.). The hydraulic power developed at that station is about 6000 hp. Another interesting feature of this plant, which deserves mention here, is that the water pumped at this station and sent into Geneva was used considerably, and is still used to some extent, in Geneva for driving water-motors; so that, in effect, the problems of power-transmission and distribution were solved here in an original manner, and with some success, *hydraulically*, several years before the problem was solved *electrically*.

Between 1893 and 1896 the city of Geneva built another larger water-power plant further down stream, below the point where the Arve River empties into the Rhone. This station is a hydro-electric station; the whole of the power developed (about 12,000 hp.) is used for driving electric generators; none of it is used for pumping.

A third station, under construction, still further down stream, will develop about 18,000 hp., and, eventually, there will be a fourth station of about 8000 hp. From what precedes, it is seen that the power already developed and available for future development, in the Swiss portion of the Rhone, aggregates over 50,000 hp.

On the French side of the frontier, the Rhone runs through deep gorges and over many falls, which, in a distance of 23 kilometers (14.3 miles) from the frontier, make an aggregate drop of from 67 to 69 meters (220 to 226 ft.), according to the time of the year. This drop, if produced at one point by a dam, would be considerably higher than Niagara Falls, which is less than 200 ft. The volume of water, which is already increased by the water emptied into the Rhone by the Arve, near Geneva, is still further increased by the water of a second stream, the Valserine, which empties into the Rhone at a point about 15 kilometers (9.3 miles) below the frontier.

The mean flow of the stream, at Genissiat, a place situated 23 kilometers (14.3 miles) from the Swiss frontier, is about 300 cubic meters (79,260 gal.) per second. The utilization of this volume, with the full drop, taken at an average of 68 meters (223 ft.), would represent a useful power of over 200,000 hp. It would seem, therefore, that this portion of the Rhone presents the opportunity for one of the largest water-power developments in France.

The possibilities of the French Upper Rhone as a source of water-power attracted attention as early as 1871, or long before electric power-transmission was even dreamed of. At that date, an English company obtained authority to build a water-power plant on the Rhone at Bellegarde, about 14 kilometers (8.7 miles), from the Swiss frontier, with the right to utilize an average fall or drop of about 12 meters (39.4 ft.), and a volume of water of 60 cubic meters (15,852 gal.) per second, which was estimated to represent a useful power-capacity of about 6400 hp. The originators of the project intended to transmit power *mechanically*, by means of long belts made of rope or cable, running over large sheaves, as had been done to some extent in England. Those "rope-drive" transmissions of mechanical power were to serve for distributing the power produced at the power-station to various factories and works located in the immediate vicinity of the station. This scheme, which was without doubt the largest and boldest scheme of power-transmission and distribution of that period, was a financial failure, because there was not enough demand for the power thus made available to make the enterprise pay. The power-plant eventually passed into the hands of another company, and it lay practically idle until interest in it was revived in the late nineties, after the problem of power-transmission had been solved by the aid of electricity.

Various projects have been proposed in recent years for the development of water-power on the French Upper Rhone. One project is based upon the plan of utilizing a fall or drop of about 20 meters (65.6 ft.), which would mean a power-capacity of 20,000 to 40,000 hp. Another project aims at the utilization of a fall of 21 meters (68.9 ft.), which would give a somewhat increased power-capacity. Reference will be made, in some detail, to a third plan, which aims to utilize, by means of a single dam and at a single power-station, the whole of the energy obtainable from the stream be-

tween the Swiss frontier and the village of Genissiat, situated 23 kilometers downstream. This project was worked out by three distinguished French engineers, Messrs. Blondel, Harlé and Mähl, in 1905. As their plans contemplated the transmission of energy by electricity from this plant to Paris, a distance of 450 kilometers (279 miles), a "White Coal Commission," composed of 31 members, including the most distinguished civil, electrical and mechanical engineers in France, and also including many able scientists, economists and men of affairs, was appointed by the Prefect of the Seine to make a full inquiry into and to report upon the feasibility and merits of the project. This commission rendered a favorable report in 1908.

In 1909 a syndicate was formed to make a complete detailed study of the technical, engineering and financial features, and to work out the more important details of the project. The work of this syndicate, which included the thorough exploration of the region, by borings, soundings, etc., was completed in the early part of 1912. The plans for the project are very complete, and they show that the work of their preparation received the most exhaustive and thoughtful study, and that it was done with great care and thoroughness, with the desire to work out the most minute details and to anticipate all difficulties and meet all objections. The two principal difficulties incidental to this proposed water-power development are: First, the sudden freshets, occasionally of flood-like character, due not to the water from Lake Lemman, whose flow is regulated and controlled by the city of Geneva at the pumping station, as already stated, but to the waters of the two tributaries, the Arve and the Valserine, which discharge into the Rhone above the proposed dam-site; second, the alluvial deposits resulting from matter eroded and then deposited by the stream at places where the current is slow. The engineers have anticipated these difficulties and have made adequate provision against them.

A few figures taken from the reports of the authors of the project will suffice to give a general idea of the project. The plans contemplate a dam at Genissiat of stone and armored concrete of 76 meters (249.3 ft.) in height, which will dam up the water to a head of 69 meters (226 ft.) in the low water season and of 64 to 65 meters (210 to 213.3 ft.) in season of high water. This will raise the stream level above the dam high enough to fill the gorges of the Rhone as far up stream as the Swiss frontier, thereby making a lake of 23 kilometers (14.3 miles) in length, which will constitute a large storage reservoir for the power-station, with a capacity such that, by allowing the level to fall 4 meters (13.1 ft.) a water reserve flow of 15,000,000 cubic meters (nearly 4,000,000,000 gal.) can be obtained, which, with the lowest head (64 meters) would represent a supply of energy of not far from 1,000,000 hp.-hours. The average power available will range from a minimum of 80,000 hp., in the low-water season, to 320,000 hp. in the high-water season; and even in the low-water season the storage reservoir will enable the plant to carry a "peak-load" of 160,000 hp. It is interesting to note that while the dam will be of lesser height than that required for the Durance project, the total power developed will be very much greater.

It is proposed to transmit electrically to Paris a portion of the energy obtainable from this plant, using three-phase current of 25 periods, at a pressure of 120,000 to 140,000 volts. The voltage will be reduced, near Paris, to a suitable voltage (about 15,000 volts) for distribution to large power consumers; and it is also proposed to use apparatus for changing the frequency and otherwise adapting the current for lighting and other requirements. A considerable portion, perhaps the greater portion, of the power developed would be



distributed at various places much nearer the power-station than Paris. The engineers assert that, since the plant will find a market for its power at all points along the whole way to Paris, there will be no difficulty in disposing of the entire power output of the plant at all times. The total cost of this development will range between 130 and 160 million frs., depending upon the extent of the transmission and distribution system.

The very magnitude of this project made it seem somewhat utopian in a country like France as it was before the war, whereas it would not have seemed so stupendous even for France, in the eyes of American engineers and capitalists, who are more accustomed to large power projects. The enormous activities in mechanical industry which have resulted from the war, and the consequent great demand for power, so sudden and so hard to meet, which occurred, have unquestionably caused a great change in opinion and in attitude, in France, on the subject of power-supply, especially since the price of coal has risen to such extraordinary figures. The project would presumably look far more attractive to-day to financiers than it did five years ago; and it is possible that some of them now regret that they did not then show more interest in it.

The estimated annual output of useful energy from this plant is 1,300,000,000 kw.-hr. To produce the same energy by steam power 1,800,000 tons of coal would be required. Allowing 25 francs per ton, the present minimum price for domestic French coal, the value of the yearly output of the plant would be 45,000,000 francs. This would be equal to 15 per cent of 300,000,000 francs of capital investment. We may say, therefore, that this is what the plant would have been worth to-day. It would not have cost anywhere near that sum. Of course, if a part of the coal which the plant would have eliminated is taken at the cost of imported coal, then the financial results are even more impressive.

There is very little reason to doubt that this important water-power development will be made some day, perhaps in the near future.

*Pyrenees and Elsewhere.*—Although a considerable amount of water-power has already been developed in this region, there is still much to be done there. The lack of market for power has been the principal drawback. It may prove possible there, as it has in the "white coal" region of eastern France, to develop electrochemical and electrometallurgical industries which would utilize a great portion of this power. This is in the minds of many people in France, and some initiative in that direction may result before long. Now that it has been demonstrated in America that very high transmission-voltages (100,000 to 140,000 volts) are practicable, the radius of territory which can be reached and served by long-distance electric power is so much increased that even places like Bordeaux come within the range of the power obtainable from the Pyrenees. A great increase may be expected in the amount of water-power developed in the region of the Pyrenees in the next few years.

A certain amount of hydroelectric power is already obtained from the Dordogne River, at Tuiliere, near the point where that river empties into the Garonne, some 40 or 50 miles east of Bordeaux. The "Southwest Power Company" which operates this plant—from which power is sent as far as Bordeaux itself—has in contemplation other hydroelectric developments farther upstream on the Dordogne which, it is expected, will bring the total power from that river up to at least 50,000 hp. There is therefore, a good prospect that Bordeaux will have, in time, a good supply of cheap electric power.

The streams in the hills of Normandy and Brittany

if properly developed under modern methods can be made to yield power in small amounts, which, however, would be only of local interest and importance.

*Outlook and Prospects.*—The water-power industry is one which is generally regarded in France as having earned the right to be encouraged and fostered by both the public and the government. The plans in process of execution and in process of preparation indicate that the aggregate power developed in France will reach 1,500,000 hp. in the next two or three years. This will be still less than one-third of the estimated total power available during the periods of lowest water; yet it will be the equivalent of five or six millions of tons of coal per year that would otherwise have to be provided to do the same work, and which would become an item of the coal shortage that has to be made up by importing coal from other countries.

*Irrigation.*—In America, water power developments are frequently identified with irrigation projects; indeed, they are, sometimes, merely incidental to such projects. In France, where the soil is not arid to any extent, the utilization of water for irrigation purposes is of secondary importance, in comparison with the development of power. Nevertheless, in certain regions, notably in the southern districts, in Provence, irrigation is capable of producing great results. Its possibilities are kept in view and the uses made of it will increase greatly in the near future. There is interesting work to be done there by the irrigation engineer in adopting the plans and methods which have proved successful in the arid regions of the United States.

*Growth of Electric Service.*—The existence of nearby and cheap sources of electric current-supply in the "white coal" region has made itself evident in facilitating and increasing the use of electricity for lighting and power in the towns and villages of the region itself, and also of neighboring regions. In many places the low cost of electric current has made it possible for even the farmer to utilize it for lighting and power, to lighten his tasks and increase his comforts. Even stables have been lighted by electricity; and the cattle has had better care, in consequence. It is stated that the supply of electric light in the farming communities has led to the increase of profitable reading and study on the part of the inhabitants, producing a cultural effect of much value, and that it has also had a favorable influence on the development of agriculture by facilitating the desire and efforts of the farmer to add to his knowledge and to improve his situation.

The facility with which the power can be distributed to families and small workmen's associations has led to the establishment of small home factory plants, not only in the village communities but even in cities like Lyons and St. Etienne and similar industrial sections, in this way giving a new impetus to home industry to counterbalance the concentration of many hands in large factory plants.

It is not in the small communities alone that there has been a great increase in the use of electricity. Indeed, one of the most striking examples of such increase is to be found in the city of Lyons, the third largest and the most important industrial city in France. The manner in which the consumption of electrical energy has grown in that city, as traced by the statistics, is very remarkable, and also very instructive, as showing how greatly reduction in the cost and improvement in the quality of service may stimulate the consumption.

The total electrical energy consumption in kilowatt-hours, supplied by the electric plants of the Lyons Gas Company, has increased from 399,100 kw.-hr. in 1897 to 35,400,000 in 1915, or, at the end of eighteen years, it was over 90 times greater. Surprising as this growth

is, there is still greater surprise in finding that 88 per cent of it occurred in the last five years of that period. Up to 1910, the annual increase in number of patrons or in total consumption was low; and the curve of growth, obtained by plotting the yearly totals of customers or of consumption, flattened out in a way that would have led any statistician to believe that the maximum of electrical consumption had been practically reached and that this maximum would probably not exceed 4,000,000 kw.-hr. per year. In April, 1910, the company made an important reduction in rates, in anticipation of the completion of its new power station, then under construction, and which was put in operation in 1911. The effect of these measures on the number of customers and on the total consumption was apparent in the total consumption for 1910, which showed an increase equal to that noted during the four previous years; and it became marked in the totals for the year 1911, which showed an increase as great as that which had occurred in the thirteen years preceding. In 1912 and in 1913 the growth in consumption was still greater (from a total of 7,000,000 to 16,500,000 kw.-hr., or an increase of more than 100 per cent in these two years). At the end of 1913, the total consumption was, in round numbers, four times larger than it was at the end of 1910. At the end of 1915 the total consumption was over eight times that for 1910, and five times that for 1911.

*Cost of Electrical Energy.*—The rates which went into effect in Lyons in 1910 fixed the cost of current, per kilowatt-hour, at 60 centimes for domestic lighting, at 55 centimes for stores, offices and factories, at 50 centimes for hotels, cafés, restaurants, theaters, churches, schools, etc., and at 40 centimes for small power consumers. Discounts were to be allowed as follows:

Amount of Discount	Lighting Current	Small Power Current
2 per cent on bills of.....	100 frs.	25 frs.
5 per cent on bills of.....	250 frs.	100 frs.
10 per cent on bills of.....	500 frs.	500 frs.
15 per cent on bills of.....	1,000 frs.	1,000 frs.
20 per cent on bills of.....	1,500 frs.	1,500 frs.
25 per cent on bills of.....		2,000 frs.
30 per cent on bills of.....		2,500 frs.

There was also a "flat" rate, per annum, for incandescent lamps. This rate varied with the kind of lamp, its candle-power, and the number of hours per day that it was to burn. For large power-current consumers there were special rates, either by meter, or else "flat," by the year. The meter rates, in centimes per kilowatt-hour, ranged from 20 for motors of 1 hp., to 16.5 for motors of 10 hp., to 13.8 for motors of 20 hp., to 12.5 for motors of 30 hp., to 10.9 for motors of 40 hp., and to 9.5 for motors of 50 hp. For still larger motors, the rates were further reduced; the lowest rate for motors working during "off-the-peak" hours, such as at night, is 5 centimes per kilowatt-hour. These prices have had to be increased since the war, on account of the high cost of coal. There is, indeed, no special desire at the present time, to induce the consumers to increase their consumption, but rather a desire to have them do the opposite, because there is so much more power needed than usual for works producing war munitions and supplies.

In a large munition works, visited by the commission, in Lyons, where the electric motors installed aggregate about 6000 hp., the electrical energy supply required is derived from two different systems of distribution. The amounts of electrical energy consumed for lighting are metered separately from those consumed for power in both cases. The cost of lighting current is the same in both cases, 20 centimes per kilowatt-hour (equivalent to about 4 cents, before the war, and to less than 3 cents with present rates of exchange). The cost of the

power current is different in the two cases; in one case it is 6.5 centimes (about 1.3 cent) for night work, and 7.5 centimes (about 1.5 cent) for day work, or an average of 7 centimes; in the other case, the average cost is about 15 centimes (about 3 cents) per kilowatt-hour, or more than double the cost of current from the first system. The total number of employees in the works was between 11,000 and 12,000, working in two shifts per day of 24 hours. The bills for electric current averaged about 2500 francs per day. The cost of electrical energy for lighting and power is kept separately for each department of the works. In the department devoted to the manufacture of 75 mm. shells the cost of electrical energy for both lighting and power was stated to be about 12 centimes per shell.

In the city of St. Etienne the prices charged for electric energy for lighting and power cannot exceed certain maximum rates which are stipulated in the franchise granted by the city to the electrical company that supplies electric current in that city. For lighting current the maximum rates decrease with the number of hours of use per year, as follows:

For the first 1,000 hours.....	55 centimes per kw.-hr.
For the next 400 hours.....	50 centimes per kw.-hr.
For the next 400 hours.....	45 centimes per kw.-hr.
For the next 1,500 hours.....	40 centimes per kw.-hr.
For all other.....	30 centimes per kw.-hr.

The number of hours of use per year is obtained by dividing the total number of kilowatt-hours consumed during the year by the total capacity of lamps installed, measured in kilowatts.

The franchise also gives the maximum figures allowable for "flat-rate" lighting current.

For power, there is a "flat-rate" scale of charges per horsepower per year, and there are also two methods of charge for "metered" current, as follows:

(a) A rate which is constant, independently of the total amount consumed per year, and which is fixed at a maximum of 30 centimes per kilowatt-hour.

(b) A rate which is not constant, but which decreases with the size of motor and the total yearly current consumption, and also requires a certain yearly minimum payment per kilowatt to be made by the consumer independently of the total current consumption indicated by the meter.

The latter method of charge (b) is that known as the "fixed-plus-variable charge" method. The variation of cost (in centimes per kilowatt-hour) with the size of motor and with the number of hours of use per year are shown in the table following:

Capacity Installed, kw.	Minimum Fixed Annual Charge Per Kw. Installed	Centimes Per Kilowatt-Hour for			
		First 1,000 hrs.	Next 1,500 hrs.	Next 2,000 hrs.	All Above 4,500 hrs.
0 to 2.....	240 frs.	30	30	25	20
2 to 4.....	200 frs.	25	25	20	15
4 to 6.....	160 frs.	20	20	15	10
6 to 10.....	155 frs.	19	15	9	5
10 to 15.....	150 frs.	18	12	8	5
15 to 24.....	150 frs.	17	11.5	7.5	5
24 to 36.....	150 frs.	16	11	7	5
36 to 50.....	150 frs.	15	10	6.5	5
50 and over.....	145 frs.	14	9.5	6	5

In St. Etienne and vicinity there is much weaving and like textile work done on looms and apparatus located in the workers' homes, and the small motors installed for these and similar purposes aggregates over 3000 hp. It is very important to have a finely graded sliding-scale for power current, like the above scale.

It will be seen, from the table, that the minimum price for metered power current comes down to as low as 5 centimes (approximately 1 cent) per kilowatt-hour, same as at Lyons. This is a very low figure, which will be a revelation to most users of electric power in American cities. This low cost would not be possible in cases where "black" coal is the principal source of energy, instead of "white" coal.



This low cost of power current shows the great benefits which have been derived in a large region of France from the development of hydroelectric power in the "white coal" region. They constitute the best possible argument in favor of further and even increased activity in the development of hydroelectric power wherever it is available in France.

For the purpose of comparison with power costs in a region where "black coal" is the only source of power, we may take the cost of electric power at Bordeaux. The power used for operating the coal and ore-handling and conveying system at the Bordeaux docks costs 12 centimes per kilowatt-hour. This is to be regarded as a low figure for electric power current derived from a steam station, even allowing for the advantage which a seaport city has of being able to get its coal supply at lower cost than an inland city. Nevertheless, this very reasonable cost is still 2.4 times greater than the lowest cost of electric power at Lyon and at St. Etienne. This is a significant fact.

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(A second article on electrochemistry and electrometallurgy in France will follow.)

**Potassium Chlorate in Japan.**—A very interesting phase in the manufacture of this product has developed since the starting of the war, in Japan. Previous to the war there was only one firm in Japan manufacturing this product. This was the Nihon Kagaku Kogyo Kabushik Kaisha, which produced 300 tons of chlorate per year. The consumption of potassium chlorate in Japan at that time was about 4000 tons per year and was imported from Germany and other European countries. Since then the number of manufacturing concerns has increased from one to at least eight, which have an annual output of over 3500 tons. At present this output exceeds the local demand and of late a considerable amount of potassium chlorate has been exported to China, Russia and the South Sea Islands. During the months of August and September the above mentioned eight firms exported a total amount of 534,268 pounds of chlorate. A peculiar phase of this industry is that the firms manufacturing this product must have the permission of the government before permitted to export.

## A Bibliography of Alloys: Binary, Ternary and Quaternary Systems Whose Equilibria Have Been Investigated

By Clarence Estes

The study of alloys in a systematic way began in the latter part of the nineteenth century coincident with the introduction of the pyrometer and the microscopical examination of metals. The introduction of these instruments made it possible to go much deeper into the study of the equilibrium diagrams of alloys. Because of the many requirements for alloys with special properties, a complete systematic study of the equilibrium diagrams of alloys should include at least the following investigations of each member of the series: (1) thermal equilibrium, (2), thermal expansion, (3) thermal-electric force, (4) molecular volume, (5) density, (6) hardness, (7) tensile strength, (8) ductility, (9) electrical conductivity, (10) solution tension, (11) magnetic susceptibility, (12) separation and identification of compounds, (13) microscopical examination, (14)<sup>1</sup> x-ray examination, (15)<sup>2</sup> optical rotation of polarized light from polished surfaces, (16)<sup>3</sup> photoelectric effect, and possibly others.

Various investigators have studied more or less completely practically all of the binary systems of the common metals and a great many of the rarer metals; also about sixty ternary systems, and several quaternary systems. Tammann<sup>4</sup> has summed up in the form of a chart the various binary systems which have been investigated under his immediate supervision at the Göttinger Institut für Anorganische Chemie. Bornemann,<sup>5</sup> Faust<sup>6</sup> and others have given short summaries of the binary systems of alloys, but so far as the writer is aware there has not been published a paper listing all the binary, ternary and quaternary systems investigated, and including a bibliography of each system. It is owing to this fact that the writer has endeavored to show in a chart all the binary systems which have been published, and also to include a list of ternary and quaternary systems which have been abstracted and published in the Chemical Abstracts up to Jan. 1, 1917, and the more important investigations prior to the publication of the Chemical Abstracts.

The chart of the binary systems investigated is published on page 274 and is immediately followed by the list of references to each system investigated.

The list of references to ternary systems investigated begins on page 281, that of references to quaternary systems investigated on page 281.

In many cases it was very difficult to decide whether the data were sufficient to justify including a system in the chart or not. No doubt, in some cases, systems have been included which some readers may think should have been omitted, while, on the other hand, some systems may have been omitted which should have been included. However, the writer, if in doubt, has endeavored to include a system rather than omit it.

Accompanying the chart is a list of references for each system investigated. A number in a square on the chart indicates that that system has been investigated, and this number refers to a citation in the list of references. Letters under certain elements in the first row indicate that those elements have had their Allotropic modifications investigated, and these letters also refer to a citation in the list of references. The bibliography has been compiled mainly from the Chemical Abstracts, from Desch's Metallography, and from original articles.

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<sup>2</sup>Z. anorg. Chem., 83, 267; 88, 265.

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## Synopsis of Recent Metallurgical and Chemical Literature

### Coal and By-Products

**The Action of Solvents on Coal.**—Very little is known as to the exact chemical character of coal, one of the most important of our mineral resources. The *Journal of the Society of Chemical Industry*, Nov. 30, 1916, gives a résumé of work done along these lines. The early attempts to extract the soluble or resinoid constituents of coal by means of solvents, met with little success. Alcohol, ether, chloroform, benzene, and acetone were tried, but ordinary bituminous coals yielded only about 1 per cent or less to the solvent, although there are one or two exceptions to this. Under high pressure (55 atmospheres) and at elevated temperatures (275 deg. C.) higher extractions have lately been made by Fischer and Gluud. Pyridine was found by several experimenters to give high extractions. With some gas coals Bedson found extractions with pyridine from 22.53 to 33.59 per cent. There is an approximation between the amount dissolved by pyridine and the percentage of volatile matter. Phenol and aniline have also been found to have considerable solvent action. From the researches of Burgess, Wheeler, Clark, and Jones, on pyridine and chloroform extractions it would seem probable that the constituents of the coal derived from gums and resins are the least stable ones, which yield paraffins on distillation, while the cellulosic degradation product is the more stable, hydrogen-yielding constituent. Little is known as to the actual identity of the constituents of coal. Several compounds have been isolated but they are present in such small proportions as to make them of theoretical interest only. The cellulosic portion consists of compounds of the furane type and compounds having structures similar to that of the carbon molecule are also present, but it is improbable that coal contains free elementary carbon. The resinic constituents are considered to consist of compounds in which alkyl, naphthene, and hydro-aromatic groupings are attached to more complex groupings. The oxygenated resinic derivatives are probably chiefly cyclic oxides, and esters, ketones, acids, etc., are almost completely absent. Free hydrocarbons are present in small quantities, but it is doubtful whether aromatic groupings exist.

**Difficulties of the British Coal-Tar Color Industry in War Time.**—The chief cause which is hindering the development of the coal-tar dye industry in England is the difficulty in obtaining adequate supplies of benzol, toluol, etc., owing to war demands. In a paper read before the Royal Society of Arts and abstracted in the *Iron and Coal Trades Review*, C. M. WHITTAKER gives some of the difficulties encountered in increasing the industry. In 1913 Great Britain imported £1,946,224 worth of coal-tar colors, representing 42,000,000 lb. of colors. It is estimated that Germany supplied



£1,800,000 of this and as the total invested capital in dyestuffs factories in England was not over £500,000 a serious problem was presented. Many of the intermediates were purchased from Germany and attention had to be turned to making these before increasing the production of finished dyes. Difficulty has been found in securing adequate chemists, in getting deliveries on apparatus and workmen to erect it and in obtaining supplies of raw materials. The Government controls the benzol and toluol supply for explosives manufacture and for use in making dyes for Government equipment. The balance is available for general dyes. Acids also—nitric and sulphuric—are vital to the dye industry and just as vital to the explosives industry, and as the supply is far short of the demand, another difficulty is encountered here.

**Recovery of Benzol from Coal Gas.**—At a meeting of the London Section of the Society of Chemical Industry, on Jan. 15, Dr. R. LESSING read a paper on "A New Method of Extracting Vaporous Constituents from Coal Gas." An abstract of the paper is given in the *Chemical Trade Journal and Chemical Engineer* of Jan. 20. Dr. Lessing stated that so far it had only been used for research purposes, but there were hopes that before long it would be made available on a commercial scale, so that it could be used on gas-works in the ordinary way both for the purpose of extracting benzol and as a check on gas manufacture generally. The principle of the process is that of a dry scrubber filled with solid absorbent material, which will strip the benzol from the gas without the employment of runnig wash oil, and from which the volatile products could be recovered by steam distillation. At first it seemed that crushed pitch would serve the purpose of the absorbent material, but it was found that its viscosity decreased to such an extent by the absorption of the solvents from the gas that it began to run after a while, and was liable to consolidate and block the passages of the apparatus. Finally a rigid material was decided upon, and broken firebrick was found to serve the purpose. The operation of the process is as follows: The gas is passed through a closed vessel which contains the porous material soaked in a volatile oil—for instance, green oil or gas oil. The inert material may consist of broken highly porous brick, or preferably of molded pieces of a definite shape, volume, weight, and available surface. The various compounds in the gas which the oil dissolves—i.e., hydrocarbons and organic sulphur compounds, which when isolated are liquid at ordinary temperatures—are absorbed. When the oil has taken up the required amount of the substance to be extracted, which will depend upon the quantity and surface of the absorbing agent, the velocity and volume of the gas, the temperature and the degree of its saturation, the actual solubility of the vapors, and the absorbing oil and the vapor pressure of the solution formed, the gas inlet and outlet valves are closed, the gas current being directed into a second vessel. Steam is then blown through the material carrying the vapors and the absorbed compounds with it to the water-cooled condenser, and finally to a receiver fitted with overflow pipes for water and crude benzol respectively. It has been found advisable to provide the "scrubber still" with a jacket to avoid the condensation of steam, particularly on the walls. It is, however, not necessary to raise the whole of the inert-carrying material to the temperature of distillation. When distillation is finished steam is shut off, and the vessel is cooled by passing water through the jacket, and the apparatus is then ready for the next scrubbing period. By employing three or more sets of scrubber stills they can

be worked in rotation, a definite schedule being arranged for the three periods of scrubbing, steaming, and cooling. As gas passes through at the rate of 5 cubic feet per hour, twenty hours only are required for a test of 100 cubic feet, whereas with the method mostly used of bubbling gas through a train of four wash bottles filled with oil a period of four days is required for a test of 100 cubic feet. In addition to this saving in time there is the extreme simplicity of the apparatus, which combines boiler, container, and superheater in one.

### Iron and Steel

**Construction of Hot-Blast Stoves.**—At the New York meeting of the American Institute of Mining Engineers, in February, LINN BRADLEY, H. D. EGBERT and W. W. STRONG, of the Research Corporation, New York, presented some suggestions for hot-blast stove construction, to be used in connection with hot-dry cleaning of the gases by electrical precipitation. The authors think it advisable to construct the stoves from the viewpoint of getting the maximum amount of heat energy in the products of combustion. The two necessary conditions are the preheating of the air added to the top gas, together with obtaining a better mixture of the air and top gas, and the lining of the stove with a brick that will withstand a high flame temperature, will conduct the heat energy along certain directions, insulate the flow of heat along other directions so as to make the flow of such energy more uniform. It is recommended that several kinds of brick be used: one type which is a good insulator of heat energy to be used for lining the stove and for making partitions through the stove to restrain the flow of heat; another type of brick or material with high refractory qualities; and a third type which will be a good conductor of heat energy.

The authors recommend that some experiments should be conducted and calculations made to determine the proper size, shape and composition of checker bricks, in the light of the points brought out in the paper. Through improvements in design and the use of a hot-dry method of cleaning the top gas, it may be possible materially to lower the installation and the operating costs of the stoves, and obtain results equal to those obtained in present practice. As for preheating the combustion air for the stoves, this is somewhat analogous to preheating the blast for the furnace, but it is unnecessary to employ as expensive a method. The combustion air could be preheated by the stove exit gases by means of suitably designed heat-exchanging apparatus placed above the stove, the preheated air being delivered to the stove burners by means of fan and duct. Calculations readily show the importance of adopting this suggestion and should be proven in practice. The hot-dry method of cleaning the top gas for burning in boilers is stated to be more efficient than the wet method for the following reasons: (1) the top gas is made cleaner than when the wet method of cleaning is used; (2) the sensible heat energy of the top gas is conserved; (3) the temperature of the gases in the boiler is increased, making possible the use of a gas of lower calorific value; (4) no slags or corrosion results from the dust settling on the furnace bricks or the boiler tubes. At the Riverside cement plant and in sulphuric acid plants the electrical method is now being used to clean gases at about 900 deg. Fahr. Several other gases have been cleaned at this temperature. A cheap and efficient method of cleaning gases at a high temperature will thus introduce a new epoch in the saving of the sensible heat energy that is now being wasted in so many instances.

## Recent Metallurgical and Chemical Patents

### Iron and Steel

**Welding.**—For welding a cutting edge of high-speed steel to a low-carbon steel shank, JOHN A. HOPE of Montreal, Canada, patents a welding composition which consists of 60 parts 80 per cent ferromanganese, 20 parts 50 per cent ferrosilicon and 20 parts burned borax (1,209,841, Dec. 26, 1916).

**Uranium Steel.**—Three patents of JOSEPH M. FLANNERY (assigned to Standard Chemical Company of Pittsburgh, Pa.) refer to the use of uranium in high-speed steel. The first patent (1,210,625) refers to the use of uranium as the sole added toughening agent and specifies a content of from 0.05 to 5 per cent of uranium in steel. In the second patent (1,210,626) it is stated that by incorporating 3 per cent of uranium into tungsten steel containing as low as 8 per cent tungsten, a high-speed steel is produced which has all the qualities of tungsten steel containing 18 per cent of tungsten. The third patent (1,210,627) refers to the analogous addition of from 0.4 to 3 per cent of uranium to molybdenum steel containing from 3 to 10 per cent of molybdenum (1,201,625, 1,201,626, 1,210,627, Jan. 2, 1917).

### Tungsten

**Method of Producing Malleable Tungsten.**—According to a patent of ARMIN HELFGOTT of Uj-Pest, Austria-Hungary, assigned to the General Electric Company of New York, better results can be obtained in making malleable tungsten if a mixture of granular tungsten and finely powdered tungsten is used as the starting material than when either of these is used singly. When the mixture is used the finely powdered metal acts as a binder upon sintering, cementing together the grains of granular tungsten. The common method of making malleable tungsten is to press dry tungsten powder into suitable forms and then sinter. It is advisable to have the tungsten powder free from oxide, and since the fine black powder always contains oxide its use alone is open to this disadvantage. When granular material only is used the adhesion is very slight between the particles. The method of using a mixture of fine and granular aims to overcome these difficulties as far as possible. The patent states that the fine powder may be freed from oxide by heating in a current of hydrogen (1,206,704, Nov. 28, 1916).

### Plating

**Nickel Plating.**—A patent of CLARK W. PARKER, assigned to the Parker Rust Proof Company of America of Detroit, Mich., refers to a quick nickelplating process. The steel surfaces to be plated are first finished and then treated with a weak solution of phosphoric acid (prepared by placing 3 lb. of manganese dioxide in a solution of  $\frac{1}{2}$  gal. of phosphoric acid in 100 gal. of water and heating to the boiling point). They are then cleaned and smoothed with a metal brush or brushed with emery or pumice, and are then immediately plated with nickel in a nickel sulphate solution. "For some reason not now understood a much higher voltage may be used in nickelplating articles thus treated than is permissible with ordinary practice, as the burning of the edges of the articles being plated, which is common with high voltage under ordinary conditions, is entirely lacking. The time required to deposit a given coat is greatly reduced (1,211,218, Jan. 2, 1917).

### Smelting

**Smoke Condenser.**—A patent was granted to FRIEDERICH W. BREITENSTEIN of Vancouver, Canada, for the condensation and recovery of sulphur and arsenic from

smelter smoke. The invention comprises a smoke flue leading from the smelter composed of a series of connected sections, each having an intake lead and a discharge lead at an angle to the intake lead at a point to the rear of the front end of said intake lead, and means at the front end of each intake lead to project the flame into the said intake lead and toward the end of the flue. The construction of the flue is given in a series of drawings (1,188,240, June 20, 1916).

**Dust Collector for Blast Furnace.**—Fig. 1 and Fig. 2 show the dust-collecting device for blast furnaces patented by PASQUALE DE SIMONEY of Youngstown, Ohio. Fig. 1 shows the device attached to the upper part of a

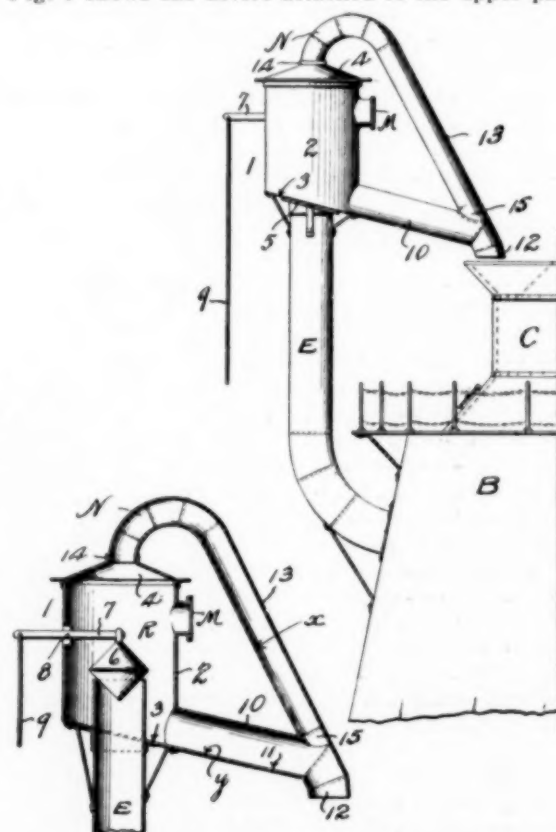


FIG. 1 AND FIG. 2—SMOKE CONDENSER

blast furnace. The underlying principle of the device is the dropping of the solid material, due to the decrease in velocity of the gases coming from the furnace as they enter the expanded chamber 2. This chamber has an inclined floor 3 and an upper cap 4. The explosion pipe *E*, as is seen in Fig. 1, enters partway into the chamber 2. The inlet of the explosion pipe is provided with a cone valve 6. The valve is operated by lever 7-8-9; 10 is a gravity return pipe and returns the solid material into the furnace. Pipe 13 is intended to carry the finer materials back to the furnace more rapidly than if the coarse and fine materials were mixed. This pipe has a greater incline than pipe 10, thus facilitating the removal of the fine material. As an explosion takes place in pipe *E*, the valve is lifted, the fine material is shot up into the neck *N* of pipe 13 and goes to the furnace, while the heavier particles drop to floor 3 and pass through the pipe 10 (1,192,395, July 25, 1916).

**Acid Resisting Strainer for Smelters.**—Figs. 3 and 4 show the construction of a bag for filtering fume patented by DONALD M. CAMERON of Lowell, Mass. It consists of a cylindrical, seamless, tubular body having its upper end closed. The material of this bag consists of yarns of camel's hair woven into the desired form. The strainer is adapted to be suspended in the flue of a



smelter, the fumes and smoke passing through it. The solid particles are withheld in the bag while the filtered smoke or fume passes to the stock. The solid materials adhering to the wall of the bag may be removed at any

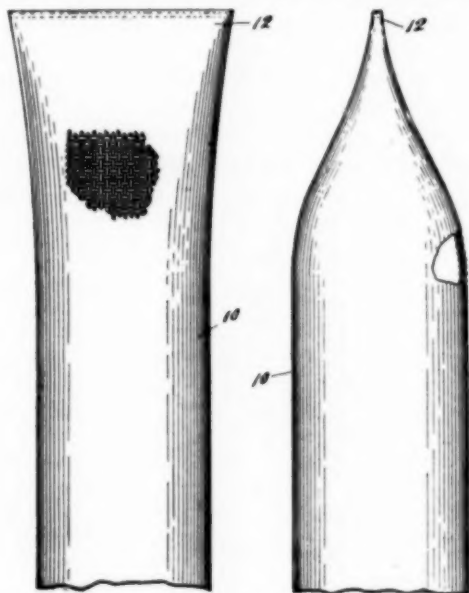


FIG. 3 AND FIG. 4—BAG FILTER

time by shaking the bag. The claim of the patent demands that the material of which the bag is made be acidproof and made up of fibers, the striations of which are longitudinal and free of scale like formations (1,190,512, July 11, 1916).

#### Electric Furnaces

**Electric Ore Reduction Furnace.**—An electric reduction furnace which embodies improvements on previous patents on the same furnace is described in a patent of JAMES W. MOFFAT of Toronto, Canada. The furnace comprises a feeding chamber for ore and flux, a reducing chamber or stack, and a crucible in which are six electrodes. The stack and crucible are a unit and can be tilted independently of the feeding hopper. When back in position after tilting, the openings in the top of the stack for exit gases and feeding are flush with the openings in the plate above, which holds the feeder and exit gas pipes. At the bottom of the stack and just above the crucible is a pipe for introducing reducing gas. In the first patent (950,595, March 1, 1910) trouble was experienced with the tapping, and these troubles were overcome in a later patent (1,108,924, Sept. 1, 1914). In this furnace the reducing chamber was disconnected from the crucible in tilting. In the present patent the crucible and reducing chamber tilt together as a unit and the loss in dusting is minimized by having the exit gas openings away from the feeding opening (1,208,817, Dec. 19, 1916).

**Electric Furnace.**—Two patents were granted to JOSEPH LAWTON DIXON of Detroit, Mich., for improvements on electric furnaces. The improvements relate especially to that type of electric smelting furnaces where the current may be made to pass either from one electrode to another over the bath or from one or more of these either wholly or in part through the bath and the furnace lining. Furthermore, it is the object of these patents to control the phase relations of the current coming from specially devised transformers by means of switches, so as to cause different proportions of the total current to flow through the bath and the lining. This is to be accomplished with either two or three-phase current systems in such a manner as not

to unbalance the load on the main lead. Fig. 5 shows one of the possible connections as given in the patents, and needs no further comment. The phase relations of

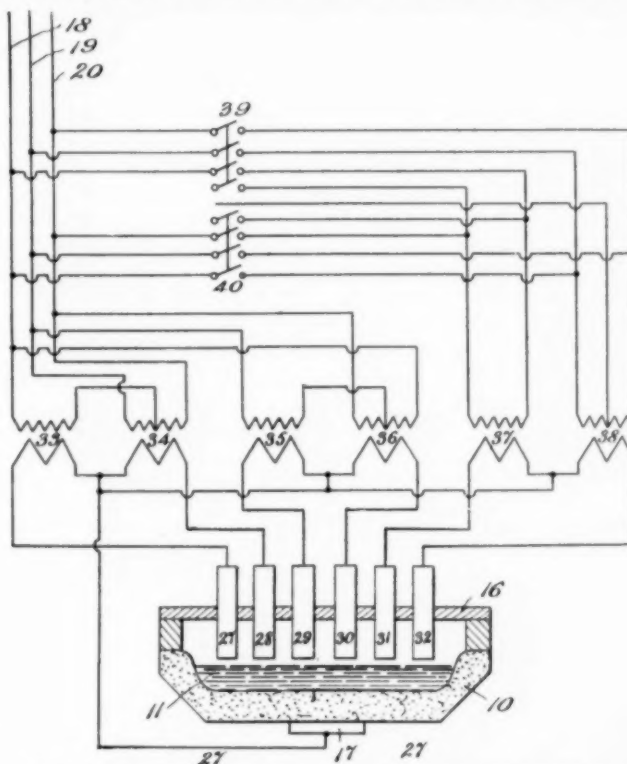


FIG. 5—DIAGRAM FOR ELECTRIC FURNACE CONNECTIONS

the currents are specially illustrated by the patentee (1,197,458 and 1,197,459, Sept. 5, 1916).

#### Various Processes

**Process for Volatilizing Metals.**—Fig. 6 illustrates an apparatus used for the volatilization of metals patented by SELDEN IRWIN CLAWSON of Salt Lake City, Utah. 7 is the roasting part of the apparatus, where the ore is roasted in the presence of air, which is supplied through 10, the same opening serving for the rabbling. Through 12 the roasted product drops into the muffle 3, which is made airtight by means of the door 4. Halogen compounds are added through 13, which is provided with a worm gear. The volatile halogen compounds issue from the muffle through 5, which leads to the fume arrester. The process consists generally in the roasting of an ore containing gold, silver, copper, lead antimony, cobalt, zinc and other metals whose halogen compounds volatilize in the presence of air and with the addition of sulphur if necessary. The sulphur is added during the roasting so as to form sulphates. The object in the roasting operation is to convert all the metals into sulphates with the exception of the iron, which should as far as possible be roasted to oxide. After converting the metals into the sulphates, halogen salt is added to the roasted product. In this state the mixture is heated in the muffle, chlorides being formed, which volatilize and are collected (1,192,037, July 25, 1916).

**Method of Making Wall Coverings.**—A method of making wall coverings which makes use of electrotyping is patented by JAMES W. MCINDOE of Medford, Mass., and ARTHUR E. WHITNEY of Winchester, Mass. If it is desired to transfer the configuration of a wood veneer to a sheet of wall board or onto paper, two pieces of wood veneer of similar design are taken. The ends are abutted together with the backs secured to a flat plant and the design joined continuously at the junction of

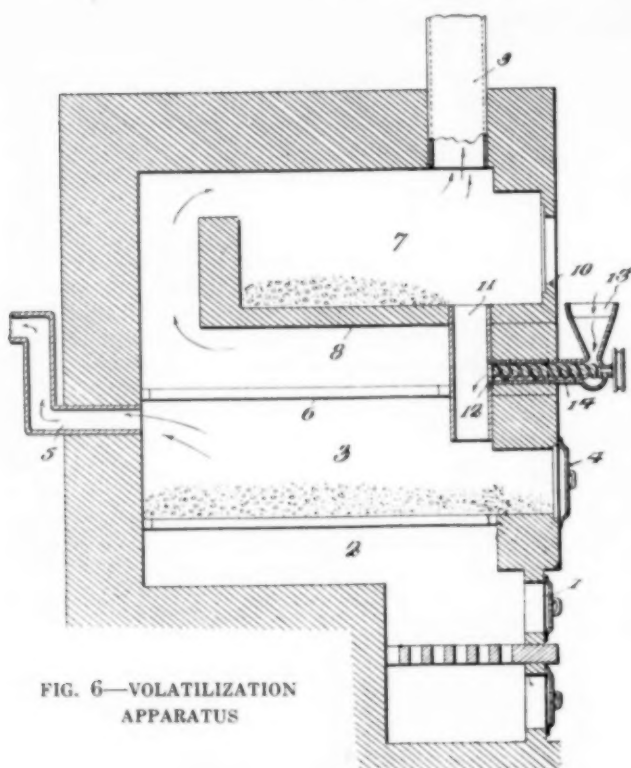


FIG. 6—VOLATILIZATION APPARATUS

the two pieces of veneer. The gum is then removed from the grain by turpentine, and the surface is spread with carbon and an electroplate formed. The electroplate is then trimmed and shaped into a cylinder with its printing face outward, and is provided with a solid backing of copper and soft metal. The cylinder is then ready for printing (1,208,808, Dec. 19, 1916).

**Production of Sugar from Sugar-Beets.**—A process of producing sugar from the sugar beet and its by-products is patented by GEORGE H. BENJAMIN of New York. The object of the patent is to make it possible to so treat the beets that they can be kept for long periods before making sugar from them, thus doing away with the disadvantages of the usual working season of only three to four months. The object is accomplished by first slicing the beets and then treating them in a dehydrator with dry air. As a result of the dehydration of beets the water is greatly reduced and the available sugar content increased as shown by the following analysis:

	Fresh cossettes Per cent	Dehydrated cossettes Per cent
Water .....	78.98	10.67
Polarization .....	14.80	65.10
Polarization on dry substances..	70.41	72.87
Invert-sugar.....	None	None

Many advantages are claimed for this dried product on account of the greater concentration of sugar and because the dried beets can be stored for a long time if kept dry (1,207,840, Dec. 12, 1916).

**Manufacture of Waterproof Cloth.**—A process of waterproofing cloths is the subject of a patent of ALFRED O. TATE of Montreal, Canada (assigned to the Tate Electrolytic Waterproofing Company, Inc., of New York). In this process the cloth or fabric to be treated is passed between two rolls which serve as electrodes, after first being treated with a saponaceous solution, preferably of common castile soap. The positive electrode or roll should be of the metal the hydroxide of which it is desired to incorporate in the fabric; in this case aluminium. The negative electrode may be of any

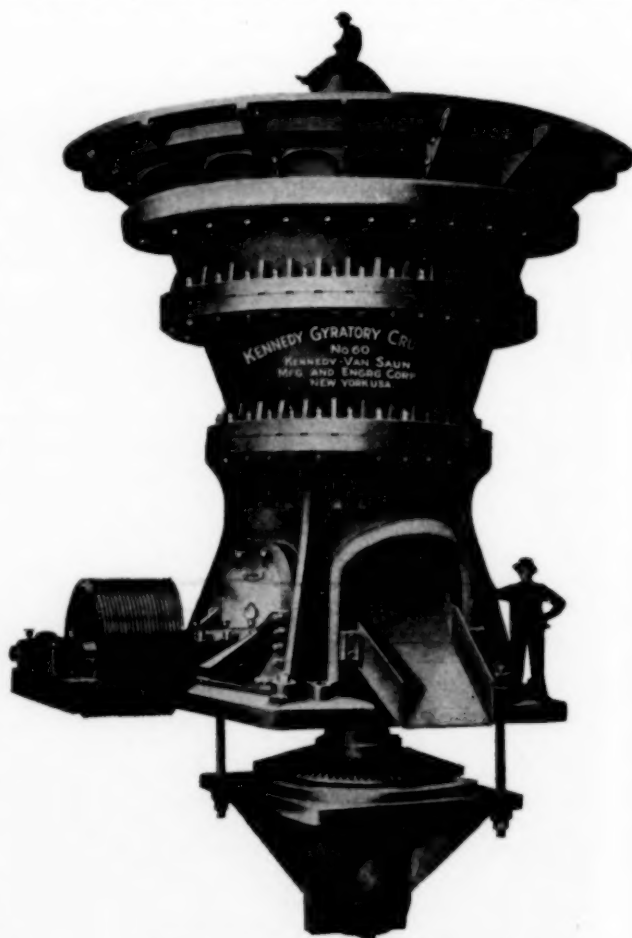
suitable material, such as graphite. While the material is passing between the electrodes, a saturated solution of aluminium sulphate is applied to the fabric by spraying or other means. At the same time the hydroxide is precipitated on the fabric from the anode and aluminium palmate is formed from the aluminium salts and the sodium palmate of the soap solution. After passing between the rolls the fabric is washed and dried (1,208,400, Dec. 12, 1916).

### A Mammoth Gyratory Crusher

What is stated to be the largest crusher in the world has recently been installed at the Michigan Limestone & Chemical Company's plant, at Calcite, Mich., by the Kennedy-Van Saun Mfg. & Eng. Corporation, 120 Broadway, New York.

The Michigan Limestone & Chemical Company is operating a property in Northern Michigan on the shores of Lake Huron, at Calcite, which is within a few miles of Rogers City. It comprises approximately twelve thousand acres of limestone land. The quarry face at the present time is about  $1\frac{1}{2}$  miles in length and has an average face height of about 50 ft. A large number of churn drills are used for drilling the full height of the face, which is shot off in successive layers with dynamite.

Six 110-ton steam shovels with  $3\frac{1}{2}$ -yd. capacity dipper are used in shoveling the blasted material into trains of eight to ten cars of ten (10) yards capacity each. These are hauled by steam locomotives on standard gage tracks. The trains are controlled by a tower man with an electric signal system so that the engine man of each train is shown which shovel he is to serve on each trip, and the delivery of the stone laden trains



THE WORLD'S LARGEST CRUSHER

is therefore systematically controlled for feeding the primary crusher.

As the tracks approach the crusher house they are arranged so that the stone can be delivered either side of the crushers. Up to the present time all of the stone has been delivered to a No. 42 Kennedy gyratory crusher, which has been in service about five years, and it has produced an average of about 16,000 tons of crushed limestone per 20 hr. day. The re-crushing operation to produce the finer sizes of stone required is accomplished with a No. 7½ Kennedy gyratory crusher.

Recently this company has installed an additional primary crusher in order to secure a large tonnage capacity, and also to receive larger stones so that the cost of quarry blasting would be minimized, and there will be less opportunity for any delay from pieces not entering the crusher on account of the receiving opening being of insufficient size.

This No. 60 crusher, which is the largest ever built anywhere in the world, commands attention, and some of its features should be of interest. It has a capacity of approximately 25,000 tons per 20-hr. day crushing limestone from a maximum size, which will enter its receiving opening, having a combined area of 60½" by about 35 ft. down to about 8" and finer.

The crushing space between the head and concaves holds 30 tons of stone and this, together with the hopper, which flares out above the head and concaves with an outside diameter of about 22 ft., affords receiving capacity of over 65 tons of stone.

The design of this unusual machine naturally involved much careful study, not only as regards to its operating features but also its manufacture and transportation. For instance, its spider, which is made in a single casting, came within one inch of the height limit permitted by railroad regulations, even when shipped in a well bottom car.

The top shell on account of its great weight could not be shipped in one piece, and was therefore constructed in two horizontal sections, connected by heavily flanged male and female tapered machined joints, securely bolted, so that its strength is increased instead of reduced by this procedure.

The main shaft is about 3 ft. diameter at its largest portion and about 28 ft. long. The total height of the machine is 34 ft. It is driven with 1¼-in. Manila ropes by a 66-in. cast steel sheave, having 18 machined rope grooves. It is operated by the English system, so if as many as half of the ropes should fail from wear the crusher can still serve, continuity of operation being of greatest importance. The source of power is a 300-hp. motor, which has been found ample for the requirements.

In the design of the various parts of this machine, the calculations were based on known factors, derived from experience with a large number of similar crushers from the smallest size up to the largest heretofore built. While the detailed processes of these calculations would manifestly involve too much space for a description of this kind, it is interesting to note that the parts of this No. 60 crusher have to withstand stresses produced by a pressure of more than 2,000,000 lb. at the crushing surfaces. The hydraulically forged steel main shaft is designed on the basis of a maximum fiber stress of 10,000 lb. per square inch, semi-steel casting of 3500 lb. per square inch and steel casting 8000 lb. per square inch.

The eccentric is of the patented spherical ball and socket type, so that this most important bearing is self-aligning. This largely explains the low power consump-

tion. This steel eccentric bearing is lined with a phosphor bronze bushing constructed in halves, thus forming the most perfect bearing construction known, and which removes the annoyance of rebabbiting, as in the case of rigid eccentric crushers. Moreover, as the proper eccentricity is maintained the reduction of capacity is avoided. The bearing pressure between the shaft and the bronze lined eccentric bearing is designed not to exceed a maximum of 175 lb. per square inch.

The broken stone from this crusher is spouted to a belt conveyor which carries it on an upward incline to revolving screens, the rejections from which are fed to smaller crushers producing the finer sizes of stone required. It is then either conveyed to ground storage or to bins from which it is loaded by shuttle conveyors on to specially built steam boats for transport on the Lakes to customers, principally large steel producers who utilize this limestone for furnace flux.

### A Remote Liquid Level Gage

A gage for showing the level of liquid in a tank at a point at a distance from this tank has been developed by the Universal Tank Gage Company, of Tacoma, Washington. A diagram of the gage and connections is shown in Fig. 1. The gage consists of a U tube containing a colored liquid. One arm of the tube is open to the air; the other is cut quite short and connected to a small reservoir of a size sufficient to hold the contents of the other arm. The top of the reservoir is connected by means of ¼-in. copper tubing to the tank; this tubing terminating in a small bell on the bottom of the tank which is placed open and downward. At the gage end of the connecting tube is a small hand air pump and valve, as shown in the illustration.

After the instrument is set up and connected to the tank, air is pumped into the tubing until it bubbles freely from the bell in tank. The air then in the tubing is under atmospheric pressure plus the head due to the height of the liquid in the tank, which is exactly counterbalanced by the column in the U-tube. As the contents of the tank is drawn off the air escapes from the bell and the column in the gage glass falls. When the tank is filled the process is reversed, but if air is

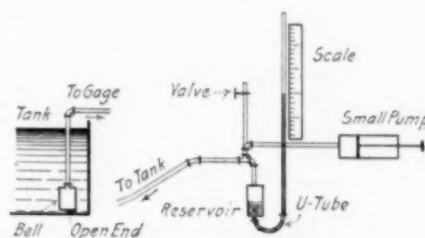


FIG. 1—DIAGRAM OF LEVEL GAGE CONNECTIONS

compressed too much and the liquid is forced into the copper tubing a few strokes of the hand pump will correct it.

The change in temperature is automatically cared for, a rising temperature merely forcing a little air out of the bell in the tank. A falling temperature will cause the column of liquid to read slightly lower than it should and this can be corrected by using the pump. There is no capillary action to be adjusted for, it is claimed, since there is no liquid in the small tube.

This gage is guaranteed to read within 1/16 in., and its operation is independent of the location of the tank. It is made in various forms for use on fuel oil, water, gasoline or any tank containing liquid.



## Recent Developments in Operating Sugar Mills

One of the most important strides of progress in the cane-sugar industry has been the installation of the electric drive in all departments of the factory or "Central"—the name in use in all Spanish countries.

The principal heavy machinery in a cane-sugar factory are the 3-roll mills and 2-roll crushers which extract the juice from the cane. Similarly to the rolls in steel-rolling mills, each cane mill is generally connected through double-reduction gearing to its individual steam engine, while other apparatus in the plant, such as centrifugals, conveyors, etc., are arranged in groups and belt-driven by separate engines. All pumps and the boiler-room auxiliaries are usually direct-acting steam units.

The first cane-sugar mill to be completely electrified was Central Amistad, located in Guines, Cuba. The electrical system was designed and installed by the Kelvin Engineering Co., Inc., of New York. The power plant contains three 1000-kw., 3-phase, 60-cycle, 480-volt turbo generators, and all mills, conveyors, pumps and auxiliaries are driven by direct-connected 3-phase motors.

The complete electrification of Central Amistad was finished in 1913, the plant at that time consisting of six 3-roll mills and one 2-roll cane crusher, capable of grinding 2200 tons of cane per 24 hours. The progress made in the electrification of sugar mills since that date is shown by the fact that up to the present time over 30 mills have adopted the system.

The advantages of the electric drive in sugar mills are similar to those obtained in other industries, especially those where the exhaust steam is used for heating, drying, evaporating or other industrial purposes. The most desirable operating condition to be obtained in a cane-sugar mill is high extraction of the sucrose or sugar in the cane with minimum fuel consumption, which in sugar factories means without the purchase of additional fuel. The fuel always used in a modern factory is the bagasse or fiber of the cane after it has been crushed and the sugar juice extracted. Whether the mill units are steam or electrically driven, high extraction can be obtained provided a sufficient quantity of maceration water, *i.e.*, water added to the crushed cane to dissolve the sugar, is used and a sufficient amount of fuel is available or purchased to evaporate this water added to the cane, but in order to secure high extraction at a minimum fuel consumption and operating expense, the mill must be electrically driven.

For example, in the majority of steam-driven sugar mills, a large amount of steam is required to furnish power to the roll and crusher-mill engines, pumps and auxiliaries. The exhaust from these greatly exceeds the amount required in a modern efficient sugar evaporating system. However, as the evaporating systems of many of the mills are very uneconomical, consuming all of the exhaust steam available from the several engines, and not infrequently additional live steam, the inefficiency of the combined equipment is not readily noticeable. To have an efficient evaporating system without a corresponding power system, or vice versa, would, of course, not be productive of economical results. In the first place, the power equipment produces more steam than can be used in the evaporators, multiple effects, etc., and in the second place this apparatus requires more steam than can be supplied by the power equipment.

As it is possible to design modern evaporating and heating systems so as to require only such quantities

of exhaust steam which may be available the first problem of economical steam consumption is solved by the installation of the steam-turbine-driven electric power plant and the electric-motor drive, and then designing the heating and evaporating system to require only the available exhaust steam. This combined equipment gives maximum extraction without the purchase of fuel. In fact, the bagasse produced by an electrified mill is always in excess of that required for fuel.

Other advantages claimed for the electrification of sugar mills besides the economy in fuel are greater ease of installation and lower first cost. In operation it is possible to vary the speed of electrically motor-driven rolls relative to the others and independently of them in accordance with the percentage of fiber in the cane and the quantity of maceration water. It is possible to stop or start, or handle in any desired way, any one of the various mills without affecting the operation of the others. Should a mill break down or otherwise become disabled, it does not affect the remainder of the plant. There is also less danger of breakage, as neither the inertia of the moving parts nor the power of the motor, which is only of sufficient size for one mill, will be enough to cause breakage should a sudden resistance, such as a piece of scrap iron or railroad iron, be accidentally encountered in the roll. Further, each motor circuit is protected by modern safety devices and overload cut-outs. The motors require no attention whatever, and the occasional starting and stopping can be attended to by a few men. If the controlling apparatus is installed on a convenient platform, according to the modern idea of centralized control, but one man is needed for the complete control of all the grinding mills.

## Personal

Dr. Herbert H. Dow lectured before the Detroit Section of the American Chemical Society on Feb. 15. His subject was "The Evolution of the American Manufacturing Industries and their probable Trend in the Future."

Mr. Francis B. Dutton, superintendent of the Lebanon, Pa., furnaces of the Bethlehem Steel Co., has resigned to become superintendent of the Wharton Steel Co.'s plant at Wharton, N. J.

Dr. G. W. Gray, formerly connected with The Texas Company as chairman of the manufacturing committee, left their employ on Jan. 1 to become manager of The Midland Refining Company at El Dorado, Kan. At this point it is expected to build an oil refinery for the refining of the Mid Continent crude.

Mr. B. E. V. Luty of Pittsburgh, Pa., has just celebrated his twenty-fifth anniversary in iron trade journalism. He started on the old American Manufacturer and Iron World of Pittsburgh (Joseph D. Weeks, editor) on Washington's Birthday, 1892, and has been at the job one way or another ever since. For many years he has been the trusted and faithful special contributor to many technical and trade journals in this country and abroad. In his special field Mr. Luty stands alone, and the many friends which his loyalty to the iron and steel industry in the past twenty-five years has won for him are wishing him an equally successful and useful career for the next quarter of a century.

Mr. Russell B. Marchant, formerly treasurer of the J. G. White & Company, Inc.; Mr. Douglas I. McKay, formerly assistant to the president of J. G. White & Company, Inc., and Mr. Sanger B. Steel, formerly manager of Paine, Webber & Company, Chicago, have

been appointed vice-presidents of J. G. White & Company, of New York.

Mr. G. R. Petterson, who has been connected with the New York office of the Barrett Co., has been appointed assistant superintendent of the Chicago plant of the company.

Mr. Victor H. Werner, formerly connected with the engineering department of the Chile Exploration Co., has become associated with Paul O. Abbe of New York City.

Mr. Carolus S. Woodwell has left the employ of the Aetna Chemical Co. at Carnegie, Pa., where he held the position of supervising chemist to accept a position as research chemist with the Benzol Products Co. at Marcus Hook, Pa.

Mr. B. G. Worth, for over fifteen years associated with Mr. Walter Kidde as electrical engineer, has in the recent incorporation of this business been elected vice-president of Walter Kidde & Co., Inc., New York City. Mr. Worth's attention was in the past devoted mainly to power plant construction and factory electrification, and recently chemical engineering, building, etc.

### Obituary

Edward Dyer Peters, the well-known professor of metallurgy at Harvard University and the Massachusetts Institute of Technology, passed away at his home in Dorchester, Mass., on Saturday, Feb. 17. He was born in Dorchester, Mass., in 1849, and graduated at the School of Mines in Freiberg in 1869, and also received a degree from Harvard in 1877. He became a lecturer at Harvard in 1903 and has been a professor of metallurgy there since 1904. He was well known to metallurgists both through his teaching activities, his books on copper smelting and other writings, and was an authority on the smelting of copper.

## CURRENT MARKET REPORTS

### The Iron and Steel Market

The markets have made considerable progress in recovering their tone since the quieting down that occurred in the fore part of February as a result of Germany's announcement of unrestricted submarine warfare. While there has been no great increase in the turnover there is decidedly more inquiry for steel products for third quarter and second half.

Buyers have become disposed to accept the view expressed by sellers, that the entrance of the United States into the war would result in greater demand for iron and steel and a tendency toward higher prices. According to the common appraisement, the chances that existed in January of iron and steel prices being lower at the close of the year have been greatly reduced by the new international developments. Possibly the common view in January was that there were even chances of prices being higher or lower by the end of the year. Now the chances seem to be distinctly in favor of higher prices.

While the steel market as a whole did not advance during February, an advancing trend was distinctly evinced. Under the lead of some of the independent pipe mills, a general advance occurred in iron and steel pipe, two points or approximately \$4 a ton in standard wrought iron and steel pipe and line pipe, and advances averaging \$4 to \$4.50 in oil country goods. The Carnegie Steel Company, which had been quoting 3.50c. on steel hoops, for delivery at mill convenience, withdrew from

the market, leaving the situation in the hands of mills quoting 4c. to 4.50c., according to delivery. A quotation of 4.50c. basis on black sheets was being made occasionally, but when the American Sheet & Tin Plate Company withdrew absolutely as a seller the sheet market became 4.75c. as minimum, prompt deliveries of small lots continuing to command 5c. to 5.25c. In no steel product has the slightest indication of weakness appeared, and thus while the market as a whole has not been advancing there has been a distinct upward trend.

### EXPORTS

Exports of such iron and steel products as are reported by weight amounted in 1916 to 6,110,790 gross tons, December exports having been 580,961 tons. Exports of unfinished steel comprised an unusual proportion of the 1916 total, 1,508,727 tons of ingots, blooms, billets, slabs and sheet bars and 158,727 tons of wire rods. Wire rods have always been classed as "unfinished steel" in the domestic trade, but the rods exported are probably to be regarded as a finished product, being used largely for the manufacture of submarine nets.

Early in February fears were entertained that American iron and steel exports would be greatly curtailed by reason of the new German submarine policy, but the prospect is otherwise now. While many American vessels failed to sail, the entente allies need as much material as formerly and commandeer such shipping facilities as are needed, while the losses in the submarine areas have been less than was expected. Iron and steel exports to neutral countries are likely to be small for the remainder of the war, but they have been far from large thus far. There has been no diminution in inquiry for export material.

### TRANSPORTATION

Transportation conditions grew steadily worse until Sunday, February 18, when, aided by moderate weather, all the railroads had an excellent movement and shippers had larger supplies of empties on Monday than for many weeks. The preceding week Connellsville coke shipments had been no more than about half the requirements, and additional furnaces tributary to Connellsville coke were forced to bank. At one time the production of pig iron at furnaces tributary to Connellsville coke, about three-eighths the total capacity of the country, was restricted by at least one-third, but with the loosening up in transportation conditions that has been more or less continuous since February 18, deliveries have been better, the volume of coke en route decreasing and there is every reason to believe the worst stage of the railroad blockade has been passed. The return to normal will be slow at best and it is doubtful whether the railroads will be able to furnish full facilities as long as the present industrial activity lasts. Thus far there has been a loss of something like a million tons in pig iron production, through transportation facilities being inadequate. The loss in steel production has been materially less, as most steel mills have had some reserves of scrap and pig iron upon which to draw.

Apart from the actual curtailment that has occurred in production, a great deal of inconvenience has been caused by car shortages and embargoes. Mills have been forced to revise rolling schedules, to suit the material available, or to fill orders that could be shipped. At most of the mills there are now large accumulations of finished product awaiting shipment. Some of it is at the bottom of piles and the orders will have to be rolled again. Even sheet mills, which are always provided with fair sized warehouses, have in several instances reached the limit of their storage capacity and have had



to curtail production to conform to the car supplies available.

#### PIG IRON

Never before in the history of the pig iron market has there been such a tangle. The usual equalization between producing districts has been impossible, on account of pig iron moving so slowly, or being blocked entirely. Ordinarily each district has its own tributary consumptive field and when a market grows weak it merely sells a larger tonnage in the twilight zone between it and the next district, but such equalizations have been impossible, when prompt deliveries only have been in request and prompt deliveries could be effected only with short hauls. Thus, for instance, the Philadelphia market is quotable at \$31.75 to \$32.75, including a freight of about 75 cents, while Buffalo iron is quotable at \$35 at furnace, when ordinarily Buffalo and eastern Pennsylvania iron compete together in New England territory. While the valley furnaces normally ship iron to points not very far from Chicago, valley foundry iron has been bringing \$35 to \$38 at furnace, while the Chicago district quotes \$32 at furnace and as far as concerns the freight rate could ship pig iron right to the valleys. Southern iron is below the parity with Chicago iron and still farther below a parity with valley iron, the Birmingham market being \$25 for prompt shipment and \$24 for second half, with a freight of \$4 to Chicago and \$4.55 to Pittsburgh, while valley iron at \$35 to \$38 has been sold to Pittsburgh consumers with a freight of 95 cents. The Alabama furnaces can ship iron, but the market is not concerned with prompt shipment. It is a matter of prompt delivery.

While valley foundry iron has been bringing \$35 to \$38, valley basic iron remains at \$30, although the cost of production is substantially the same. In this case the divergence is not that there is an abnormally heavy consumptive demand for foundry iron, it is rather that the steel mills were more forehanded in contracting for basic iron while, on the other hand, the furnaces long ago concluded there would be more demand for basic iron than for foundry and planned their production accordingly, thus forestalling the condition they intended to anticipate.

#### Non-Ferrous Metal Market

*Friday, Feb. 23.*—The freight congestion has had considerable effect on the lead market and has forced prices for prompt shipment to a very high level. It has had practically no effect on the spelter market, but has affected copper to some extent. Tin has declined considerably, owing to a good volume of arrivals. Antimony declined about the middle of the month, but recently has become firmer and advanced again.

*Copper.*—During the greater part of the past fortnight the copper market has been quiet. On Feb. 13 prompt electrolytic was offered at 35 cents and prompt lake at 34 cents. Despite freer offerings around the 15th there has been a slight advance and 37 cents is now asked for electrolytic and 35.50 for lake. Exports so far reported are 22,191 tons. It will be interesting to see what effect an improvement in the freight situation will have on copper.

*Tin.*—There has been a steady decline in tin since the high of 56 cents following the severance of diplomatic relations with Germany. This has been due to the good volume of arrivals, totaling over 3000 tons so far, and the 3000 tons afloat. The shipping scare has somewhat worn off. On the 21st it is understood that advices were received stating that shipments from the East Indies would be curtailed. From 53.25 on Feb. 13 tin declined steadily to 48.75 on the 20th, and then strengthened to 40 on the 21st.

*Lead.*—The Trust price of lead was raised to 8.50 on

the 9th. The lead situation has become increasingly serious and the freight embargoes have caused a great shortage. Independents' asking prices have risen until 10 $\frac{1}{4}$  cents have been paid for prompt lead, with early deliveries hard to get. The situation eased a little on the 21st.

*Spelter.*—In spite of the freight congestion spelter has advanced but a small fraction of a cent. Consumers are evidently well stocked. The market has been quiet, with producers showing little desire to push sales of futures on account of the high ore prices.

*Other Metals.*—Antimony has had a rocky career, declining to 29 on the 15th and then strengthening and advancing to 34 on the 20th, where it remains unchanged. The antimony market is very sensitive, owing to the uncertainty in the shipping situation, and the good demand. Aluminium is unchanged at 57 to 59 cents, magnesium can be had at \$3 to \$3.50, nickel is unchanged at 50 cents for electrolytic. Cadmium is \$1.50, quicksilver \$135, platinum (pure) \$105 per ounce, cobalt \$1.50 and silver 77 $\frac{1}{2}$ ¢. Silver was up to 79 on the 13th.

#### Chemical Market

The two factors that have been given the closest attention and that have played the most important rôles in the general chemical situation during the fortnight are the embargo that has been declared by railroads throughout the country on all freight except foodstuffs destined to this territory, and the unprecedented ocean shipping situation caused by the German submarine policy inaugurated on the first of this month. The former condition has resulted in a tighter situation in all chemicals ordinarily shipped to this center for distribution along the Atlantic seaboard, New England and other Eastern points. On the other hand, those goods, large consignments of which had been delivered here for export and are awaiting freight room, have felt the stress of delay. There is a consequent falling off in activity in those articles usually subject to good foreign demand.

Several price changes have occurred in the coal tar crudes, and these have affected to some extent the values of the many of the intermediates. The prices of benzol, toluol and naphthaline have stiffened, and phenol, which has been subject to considerable hammering in a downward direction, has taken an upward turn.

*Benzol*, although being produced now on a larger scale than ever before in this country, has been subject to a much wider demand for the use of explosives and for use in the manufacture of a more varied list of intermediates. The supplies available for immediate delivery and near futures have dwindled, and considerable difficulty is experienced in securing important quantities for consumption by users who are not under contract with manufacturers. The anticipation of government business has also played a part in stiffening the attitude of leading makers. The contract situation is less pressing, and no great movement is noted; manufacturers are not looking for contract business, and those consumers who are not covered for future requirements evince a desire to hold off, awaiting future developments.

*Toluol* has been subject to quite some buying for ultimate use of the government and important manufacturers are holding their product with considerable firmness. A few rather important contracts have lately been closed, and the majority of these have been placed at levels that show the firmness of the situation.

*Naphthaline* business is progressing on an enormous scale, and large producers are not showing any desire to take on business for contract, except with regular



users. Quantities held in second hands are being let out, however, and this is making the situation less tense, although these resale lots are commanding prices that average well up with the figures quoted by manufacturers. The English goods, owing to the high original cost, and the import duty of approximately 4c., are not being imported now to any extent.

Although *phenol* had been sold down to comparatively low levels, and more than one important manufacturer was offering goods at prices that were considerably below the ideas of other producers, the situation has changed. One of these makers was selling against a repudiated contract, and the goods have been almost entirely absorbed. The situation is now firmer, and some heavy purchases have been made in the last two weeks.

*Aniline oil*, aniline salts, dinitro phenol, dinitro chlor benzol, phthalic acid, monochlor benzol, diphenylamine, acetic anhydride have all been subject to heavy buying, and prices for the most part have increased.

Commercial alpha naphthol is now being made by a firm in the Middle West, and offerings are made for immediate delivery on contract. Ortho and para nitro toluol are also being made commercially on a larger scale, and moderately heavy demand obtains.

Owing to the entrance of a new manufacturer of alpha naphthylamine into the market, prices for this product are quoted in some directions at lower levels, although the pioneer maker has not changed his idea of price.

Among the heavy chemicals *bichromate of soda* has perhaps been given the most attention. Following a long siege of weak selling, attended by more or less steady declines, considerable demand set in from consumers at the low prices, and the market has in consequence taken an upward turn. Many speculative operators had been selling short, and these are now still buying to cover. A few at least have lost considerable money especially during the last week. This may be only a temporary state of activity, as many of the large users are under contract, and two of the most important consumers of this product are now making their own supplies. One manufacturer on the Pacific coast is now making an unusually good product, partly for its own consumption, and partly for the open market.

*Hydrosulphite of soda* has caused considerable attention lately, and one of the large textile mills is preparing to manufacture the product for its own use. Other users are showing interest and a wider demand is anticipated which will, of course, permit of an outlet for surplus quantities of the sulphur dioxide.

During the last few days *caustic soda* has been subject to unusually heavy demand, and prices have advanced both for spot, near future and contract. The sinking of a ship bound for Marseilles carrying an important consignment and the export demand for shipment to the Orient have been factors in creating a firmer market. Manufacturers are and have been limiting their contract deliveries and a large percentage of the weak lots offered by second hands have been taken out of the market.

*Bleaching powder*, on the other hand, has remained in a listless condition, and goods packed in large domestic drums, as well as in export containers, are offered more liberally than heretofore. But little buying interest is shown.

The situation in the *mineral acids* is strengthening, and higher prices are asked for the muriatic, nitric and sulphuric. Recent sales of the last named (the 66 deg. brimstone grade) have passed at materially higher levels than those that have prevailed for some time. One producer of sulphuric acid is now offering quantities of sulphuryl chloride on the open market.

At least one important order of 80 per cent redistilled *acetic acid* for English account is in the process of being filled. Important manufacturers are holding steadily, and some are quoting only for delivery in April and forward. The Glacial grade is not subject to any great demand although foreign orders are being held in abeyance, in the anticipation of concessions from producers. The makers, we believe, however, realize this, and are sitting tight.

*Quicksilver* have taken a few sharp upward jumps, owing to the facts that production and shipping to the east have been curtailed by the difficulty in carrying on mining operations during the severe weather, and the freight embargo from the west.

*Glycerine* was active for a few days last week, and some important orders were placed for the dynamite grade. The market has settled somewhat, and, while firm, no important business is passing in either the dynamite or c.p. grades.

*Nitrate of soda* has taken sensational advances, owing to the cutting down of imports, and the scarcity of resale lots.

*Pharmaceuticals*.—All of the bromides have been sharply reduced, owing to the absence of demand and the keen competition that has existed for many months.

All opium derivatives, due to the high cost and the absolute scarcity of this product, have advanced materially, and regular consumers are forced to pay unusually high prices.

Rochelle salts, seidlitz mixture, cream of tartar and tartaric acid have all been advanced by manufacturing chemists, owing to the scarcity of the raw materials.

Citric acid and quinine, two highly speculative articles, are subject to less pressing demand, and the second-hand market has eased off considerably.

### General Chemicals

WHOLESALE PRICES IN NEW YORK MARKET		FEB. 21, 1917.	
Acetone, Drums	.....lb.	.23	— .23½
Acid, acetic, 28 per cent.	.....100 lb.	3.25	— 3.50
Acetic, 56 per cent.	.....100 lb.	6.80	— 7.25
Acetic, glacial, 99½ per cent carboys	.....lb.	.23	— .23½
Boric, crystals	.....lb.	.11½	— .12
Citric, crystals	.....lb.	.74	— .75
Hydrochloric, commercial, 18 deg.	.....lb.	.01½	— .01¾
Hydrochloric, 20 deg.	.....lb.	.01½	— .01¾
Hydrochloric, C. P., conc. 22 deg.	.....lb.	.01½	— .01¾
Hydrofluoric, 30 per cent, in barrels	.....lb.	.04½	— .05
Latic, 44 per cent.	.....lb.	.11½	— .12
Latic, 22 per cent.	.....lb.	.04½	— .04¾
Nitric, 36 deg.	.....lb.	.04½	— .05
Nitric, 42 deg.	.....lb.	.05½	— .06
Oxalic, crystals	.....lb.	.46	— .48
Phosphoric, 85 per cent.	.....lb.	.28	— .32
Picric	.....lb.	.65	— .75
Pyrogallol, resublimed.	.....lb.	3.50	— 3.75
Sulphuric, 60 deg.	.....lb.	\$19.00	— \$22.00
Sulphuric, 66 deg.	.....lb.	27.00	— 30.00
Sulphuric, oleum (Fuming), tank cars.	.....lb.	35.00	— 40.00
Tannic, U. S. P. bulk	.....lb.	.45	— .50
Tartaric, crystals	.....lb.	.83½	— .84
Alcohol, grain, 188 proof.	.....gal.	2.72	— 2.74
Alcohol, wood, 95 per cent.	.....gal.	1.00	— 1.02
Alcohol, denatured, 180 proof.	.....gal.	.68	— .67
Alum, ammonia lump.	.....lb.	.04½	— .04¾
Alum, chrome ammonium	.....lb.	.17½	— .20
Alum, chrome potassium	.....lb.	.32	— .35
Alum, chrome sodium	.....lb.	.12	— .12½
Alum, potash lump.	.....lb.	.05½	— .05¾
Aluminum Sulphate, technical	.....lb.	.01½	— .02
Aluminum Sulphate, iron free	.....lb.	.03½	— .03¾
Ammonia aqua, 26 deg. carboys	.....lb.	.05½	— .05¾
Ammonia anhydrous	.....lb.	—	—
Ammonium carbonate	.....lb.	.12½	— .13
Ammonium nitrate	.....lb.	.15	— .16
Ammonium sulphate, domestic	.....lb.	.04½	— .04¾
Amyl acetate	.....gal.	3.50	— 4.00
Arsenic, white	.....lb.	.11	— .11½
Arsenic, red	.....lb.	.25	— .60
Barium chloride	.....ton	90.00	— 95.00
Barium sulphate (Blanc Fixe) powder	.....lb.	.04½	— .04¾
Barium nitrate	.....lb.	.11	— .12
Barium peroxide, basis 70 per cent.	.....lb.	.27	— .30
Bleaching powder, 35 per cent chlorine	.....lb.	.03½	— .03¾
Borax, crystals, sacks	.....lb.	.07	— .07½
Brimstone, crude	.....ton	28.50	— 29.00
Bromine, technical	.....lb.	1.30	— 1.35
Calcium, acetate, crude	.....lb.	.03	— .03½
Calcium, carbide	.....ton	80.00	— 90.00
Calcium chloride, 70-75 p. c., fused, lump ton	.....lb.	23.00	— 24.00
Calcium, peroxide	.....lb.	1.70	— 1.75
Calcium, phosphate	.....lb.	.01	— .01½
Calcium, sulphate	.....lb.	.30	— .32

Carbon bisulphide	lb.	.04	—	.04 1/2
Carbon tetrachloride, drums	lb.	.15 1/2	—	.16 1/2
Caustic potash, 82-92 per cent.	lb.	.78	—	.80
Caustic soda, 76 per cent.	100 lb.	4.25	—	4.30
Calcimine, liquid	lb.	.15	—	.16
Cobalt sulfate	lb.	—	—	—
Copper	100 lb.	1.10	—	1.15
Copper carbonate	lb.	.37	—	.38
Copper cyanide	lb.	.70	—	.70
Copper sulphate, 99 p. c., large crystals	lb.	.09 1/2	—	.10
Cream of tartar, crystals	lb.	.43	—	.43 1/2
Epsom salt, bags	100 lb.	2.25	—	2.50
Formaldehyde, 40 per cent.	lb.	.11 1/2	—	.12
Glauber's salt	100 lb.	.60	—	.70
Glycerine, bulk, C. P.	lb.	.54	—	.55
Iodine, resublimed	lb.	3.50	—	3.55
Iron oxide	lb.	.02	—	.08
Lead acetate, white crystals	lb.	.13 1/2	—	.14
Lead arsenate	lb.	.09	—	.09 1/2
Lead nitrate	lb.	.16 1/2	—	.16 1/2
Litharge, American	lb.	.08 1/2	—	.09 1/2
Lithium carbonate	lb.	1.02	—	1.03
Manganese dioxide	lb.	.60	—	.65
Magnesium carbonate, tech.	lb.	—	—	—
Nickel salt, single	lb.	.14 1/2	—	—
Nickel salt, double	lb.	.11 1/2	—	—
Phosphorus, red	lb.	1.12	—	1.15
Phosphorus, yellow	lb.	.75	—	.80
Potassium bichromate	lb.	.37	—	.38
Potassium bromide granular	lb.	1.00	—	1.01
Potassium carbonate calcined, 80-85 p. c.	lb.	.30	—	.32
Potassium chlorate, crystals	lb.	.62	—	.64
Potassium cyanide, 98-99 per cent.	lb.	2.00	—	2.10
Potassium iodide	lb.	2.90	—	2.92
Potassium muriate 80-85 p. c. basis of 80 p. c. ton	410.00	—	—	425.00
Potassium nitrate	lb.	.31	—	.32
Potassium permanganate	lb.	3.75	—	4.00
Potassium prussiate, red	lb.	2.50	—	2.55
Potassium prussiate, yellow	lb.	.87	—	.89
Potassium sulphate, 90-95 p. c. basis 90 p. c. ton	325.00	—	—	350.00
Rochelle salts	lb.	.36 1/2	—	.37
Sal ammoniac, gray gran.	lb.	.10	—	.12
Sal ammoniac, white gran.	lb.	.18	—	.19
Sal soda	100 lb.	1.10	—	1.15
Salt cake	100 lb.	.95	—	1.00
Silver cyanide	lb.	.72	—	.75
Silver nitrate	oz.	.48	—	.50
Soda ash, 58 p. c., light, flat	100 lb.	2.80	—	2.90
Soda ash, 58 p. c., dense, flat	100 lb.	3.45	—	3.55
Sodium acetate	lb.	.09	—	.10
Sodium benzoate	lb.	7.00	—	7.50
Sodium bicarbonate, domestic	100 lb.	1.90	—	2.00
Sodium bicarbonate, English	lb.	.03	—	.03 1/2
Sodium bichromate	lb.	.17 1/2	—	.18
Sodium bisulphite, powd.	lb.	.04 3/4	—	.05
Sodium chlorate	lb.	.25	—	.27
Sodium cyanide	lb.	1.15	—	1.30
Sodium fluoride, commercial	lb.	.11 1/2	—	.13
Sodium hyposulphite	lb.	.01 1/2	—	.01 3/4
Sodium nitrate, refined	lb.	.05	—	.05 1/2
Sodium nitrite	lb.	.11	—	.11 1/2
Sodium peroxide	lb.	1.00	—	1.15
Sodium phosphate (tri)	lb.	.04 1/4	—	.04 3/4
Sodium prussiate, yellow	lb.	.31	—	.32
Sodium silicate, liquid	100 lb.	1.05	—	1.25
Sodium sulphide, 30 per cent crystals	lb.	.02 3/4	—	.03 1/4
Sodium sulphite	lb.	.02 1/2	—	.03
Strontium nitrate	lb.	.28	—	.30
Sulphur chloride, drums	lb.	.09 3/4	—	.10
Sulphur dioxide, liquid, in cylinders	lb.	.71	—	.70
Sulphur, flowers, sublimed	100 lb.	2.30	—	2.40
Sulphur, roll	100 lb.	1.90	—	2.00
Sulphur, crude	ton	36.50	—	38.00
Tin bichloride, 50 deg.	lb.	.14	—	.15
Tin oxide	lb.	.47	—	.50
Zinc carbonate	lb.	.26	—	.27
Zinc chloride	lb.	.13	—	.13 1/2
Zinc cyanide	lb.	.50	—	.52
Zinc dust	lb.	.20	—	.21
Zinc oxide, American process XX	lb.	.11 1/2	—	—
Zinc sulphate	lb.	.06 1/4	—	.07

## Coal Tar Products (Crude)

Benzol, pure, water white	gal.	.58	—	.60
Benzol, 90 per cent.	gal.	.54	—	.60
Toluol, pure, water white	gal.	1.80	—	1.85
Xylol, pure, water white	gal.	1.00	—	1.20
Solvent naphtha, water white	gal.	.22	—	.23
Solvent naphtha, crude heavy	gal.	.15	—	.17
Creosote oil, 25 per cent.	gal.	.25	—	.26
Dip oil, 20 per cent.	gal.	.22	—	.24
Pitch, various grades	ton	7.50	—	20.00
Carbolic acid, crude, 95-97 per cent.	lb.	.85	—	.90
Carbolic acid, crude, 50 per cent.	lb.	.55	—	.60
Carbolic acid, crude, 25 per cent.	lb.	.25	—	.30
Cresol U. S. P.	lb.	.18	—	.22

## Intermediates, Etc.

Alpha naphthylamine	lb.	1.00	—	1.25
Aniline oil	lb.	.26	—	.29
Aniline salts	lb.	.27	—	.30
Anthracene, 80 per cent.	lb.	.10	—	.10 1/2
Benzaldehyde	lb.	4.00	—	4.50
Benzidine, base	lb.	1.60	—	1.80
Benzidine, sulphate	lb.	—	—	—
Benzoic acid	lb.	8.00	—	8.50
Beta Naphthol, sublimed	lb.	.80	—	.90
Dichlor benzol	lb.	.48	—	.50
Dimethylaniline	lb.	.55	—	.60
Diphenylamine	lb.	.80	—	.85
H-acid	lb.	Nominal	—	—
Metaphenylenediamine	lb.	1.50	—	1.65
Monochlorbenzol	lb.	.32	—	.35
Naphthalene, flake	lb.	.09 1/4	—	.09 1/2
Naphthalenic acid, crude	lb.	1.75	—	2.00
Nitro-naphthalin	lb.	.45	—	.50

Ortho-amidophenol	lb.	—	—	—
Ortho-toluidine	lb.	1.20	—	1.30
Para-amidophenol base	lb.	4.25	—	4.50
Paranitraniline	lb.	1.20	—	1.30
Paraphenylenediamine	lb.	3.50	—	4.00
Paratoluidine	lb.	1.50	—	1.80
Phenol, U. S. P.	lb.	.45	—	.47
Resorcin, technical	lb.	9.00	—	—
Resorcin, pure	lb.	17.00	—	17.50
Salicylic acid	lb.	.80	—	.85
Sulphanilic acid	lb.	1.40	—	1.50
Tolidin	lb.	.30	—	.32
Toluidine-mixture	lb.	3.00	—	—
	lb.	.90	—	1.00

## Petroleum Oils

## CRUDE (AT THE WELLS)

Pennsylvania	bbl.	3.05	—	—
Corning, Ohio	bbl.	2.38	—	—
Somerset, Ky.	bbl.	2.18	—	—
Wooster, Ohio	bbl.	2.05	—	—
Indiana	bbl.	1.73	—	—
Illinois	bbl.	1.87	—	—
Oklahoma and Kansas (except Healdton)	bbl.	1.70	—	—
Caddo, La. light	bbl.	1.70	—	—
Corsicana, Tex., light	bbl.	1.70	—	—
California	bbl.	.73	—	.82

## Lubricants

Black, reduced, 29 gravity, 25-30 cold test	gal.	.13 1/2	—	.14
Cylinder, light	gal.	.21	—	.26
Cylinder, dark	gal.	.18	—	.19
Extra cold test	gal.	.26	—	.31
Paraffine, high viscosity	gal.	.29 1/2	—	.30
Paraffine, 0.903 spec. gr.	gal.	.21 1/2	—	.22
Paraffine, 0.865 spec. gr.	gal.	.18 1/2	—	.19

## Flotation Oils

Pine oil, steam distilled, sp. gr. 0.925-0.940	gal.	.55 1/2	—	—
Pine oil, destructively distilled, sp. gr. 0.920-0.940	gal.	.46 1/2	—	—
Pine-tar oil, sp. gr. 1.025-1.035	gal.	.19 3/4	—	—
Pine-tar oil, double refined, sp. gr. 0.965-0.990	gal.	.30	—	—
Pine oil, light, sp. gr. 0.950, tank cars	gal.	.35	—	—
Pine oil, heavy, sp. gr. 1.025, tank cars	gal.	.23	—	—
Pine tar, thin, sp. gr. 1.060-1.080	gal.	.19	—	—
Turpentine, crude, sq. gr. 0.980-1.000	gal.	.38	—	—
Hardwood oil, f.o.b. Michigan, sp. gr. 0.960-0.990	gal.	.16	—	—
Hardwood oil, f.o.b. Michigan, sp. gr. 1.06-1.08	gal.	.16	—	—
Creosote, coal tar neutral, sp. gr. 0.990-1.010	gal.	.14	—	—
Creosote, coal tar, acid, sp. gr. 0.995-1.015	gal.	.19 1/2	—	—

## Vegetable and Other Oils

China wood oil	gal.	.13 1/4	—	—
Cottonseed oil, crude	gal.	.79	—	.81
Linseed oil, raw	gal.	.93	—	—
Peanut oil, crude	gal.	.88	—	.90
Rosin, 280 lb.	bbl.	6.30	—	—
Rosin oil, first run	gal.	.38	—	—
Rosin oil, fourth run	gal.	.70	—	—
Soya bean oil, Manchuria	gal.	.13	—	—
Turpentine, spirits	gal.	.52	—	—

## Miscellaneous Materials

Barytes, floated, white, domestic	ton	25.00	—	35.00
Barytes, prime white, foreign	ton	38.00	—	40.00
Beeswax, white pure	lb.	.52	—	—
Carnauba wax, highest grade	lb.	.51	—	.52
Chalk, light, precipitated, English	ton	.04 1/2	—	—
Feldspar	ton	8.00	—	12.00
Fuller's earth, powdered	100 lb.	.50	—	1.05
Oxokerite, crude, 15-ton lots, foreign	lb.	.51	—	—
Red lead, dry, carloads	ton	.10	—	.10 1/2
Soapstone	ton	10.00	—	12.50
Talc, American, white	ton	10.00	—	13.00
White lead, dry	lb.	.08 3/4	—	.09

## Refractories, Etc.

## (F.O.B. WORKS)

Chrome brick	net ton	Nominal	—	—
Chrome cement Grecian	net ton	80.00	—	90.00
Clay brick, first quality fireclay	per 1000	40.00	—	50.00
Magnesite, Grecian, dead burned	net ton	85.00	—	90.00
Magnesia brick, Grecian, 9 x 4 1/2 x 2 1/2	net ton	135.00	—	140.00
Silica brick	per 1000	40.00	—	45.00

## Ferroalloys

Ferro-carbon-titanium, f.o.b. Niagara Falls, N. Y.	lb.	.12 1/2	—	—
Ferromanganese	lb.	Nominal	—	—
Ferromanganese, domestic, delivered	ton	275.00	—	300.00
Ferromanganese, English	ton	185.00	—	—
Ferromolybdenum, per lb. of Mo.	ton	4.00	—	—
Ferrosilicon, 50 p. c. carloads, del. Pittsburgh	ton	150.00	—	175.00
Ferrosilicon, 50 p. c. contract, del. Pittsburgh	ton	100.00	—	—
Ferrotungsten, 75-85 p. c., f.o.b., Pittsburgh	lb.	2.20	—	—
Ferrovanadium, f.o.b. works	lb.	2.75	—	3.00



# INDUSTRIAL

*Financial, Construction and Manufacturers' News*

## Financial

The Air Reduction Sales Co., Inc., has been authorized to do business in Delaware, with a capital of \$25,000. The business is given as oxygen, nitrogen and liquid air. Representative M. W. Randall, 120 Broadway, New York City.

The Amargosa Copper Company, Spokane, Wash., has been incorporated in Washington with a capital of \$1,000,000 by C. D. Muxen, G. A. Hinkle, and A. M. P. Spalding.

American Tanning Corp., New York, has been incorporated with a capital of \$20,000 to manufacture hides, skins, leather, tanneries. The incorporators are A. Woodcock, C. J. Kulberg, J. J. Salenker, 566 West 171st Street.

Arc Iron Works, Inc., has been incorporated with a capital of \$5,000 to engage in business in steel, iron and metals. The incorporators are J. Cohen, L. Brooks, I. Fein, 187 Sutter Avenue, Brooklyn.

Atwell Chemical Co., New Haven, Conn., has been incorporated with a capital of \$4,500. The incorporators are W. L. Atwell, C. F. Spalding and S. M. Spivak.

The Auto Aid Manufacturing Co., Milwaukee, Wis., has been incorporated with a capital of \$150,000 to manufacture, sell and deal in and with chemical preparations of all kinds. The incorporators are Chas. Lanier, J. Lange, A. Lurman, John Jeperington all of Milwaukee.

Boston-Miami Lead & Zinc Co., Boston, Mass., has been incorporated with a capital of \$900,000. The incorporators are A. W. Pitman, D. Blanchard, 3 Pine Street, Winchester, and G. B. Gifford.

The Brown Disinfectant & Chemical Company, Philadelphia, Pa., has been incorporated with a capital of \$85,000, to manufacture disinfectants, medical and chemical preparations of all kinds. The incorporators are Irving M. Stewart, Philadelphia, Pa., Thomas N. Brown, Charles H. S. Clifford, Wilmington, Del.

The By-Products Co., Louisville, Ky., has been incorporated with a capital of \$5,000 to manufacture chemicals. The incorporators are A. Reutlinger and Barton Fox and Walter S. Lapp.

The Calumet Mining Company has been incorporated in Utah to take over the interests of the Mines Development Company in the Iron County district, and particularly the lease and bond privileges on the Arrowhead property, 28 miles from Sahara.

Campbell & Wiswell, Inc., Boston, Mass., has been incorporated with a capital of \$20,000 to manufacture paints, shellac, all kinds. The incorporators are E. H. Johnson, Jas. R. Flanagan, 17 Milk Street, and W. H. Rutherford.

Chemico-Minerals Corp., Yonkers, N. Y., has been incorporated with a capital stock of \$25,000 to engage in business in minerals, nitrates, etc. The incorporators are H. S. Fisher, G. Fountain, N. M. Kennedy, 140 Remsen Street, Brooklyn.

The Cleveland Chemical Company, Cleveland, Ohio, has been incorporated with a capital of \$10,000. The incorporators are B. F. Friedman and others.

Commercial Acid Co., East St. Louis, has been incorporated with a capital of \$2,000,000 to manufacture chemicals. The incorporators are Jeffries & Corum, 1112 Central National Bank Building, St. Louis, Mo.

Commercial Products Corp., New York, has been incorporated with a capital of \$5,000, to manufacture dyes and chemicals. The incorporators are G. W. Roosevelt, Jr., J. Deseau, J. Staler, 575 Riverside Drive.

Comstedt & Co., Inc., Manhattan, has been incorporated with a capital of \$100,000 to deal in iron, steel, metal work, etc. The incorporators are J. T. A. Comstedt, 120 Broadway, New York City; W. H. Wadlington, 353 West 166th Street, New York City; G. L. Robinson, 647 Tenth Street, Brooklyn.

The Consumers Dye Wood Products Corporation has been incorporated with a capital of \$10,000 to engage in business in natural vegetable dyes. The incorporators are W. D. Marburg, M. Flynn, R. L. Moffett, 471 Park Avenue.

The Crucible Clay Company of New York has been incorporated in Delaware with a capital of \$2,000,000 to acquire lands containing oil, clay, coal, etc. Incorporators: Herbert E. Latter, Norman P. Coffin, and C. M. Egner of Wilmington, Del.

H. B. Davis Co., Wilmington, Del., has

been incorporated with a capital of \$200,000 to manufacture paints, oils and other supplies.

Henry L. Doherty & Co. has formed a new \$20,000,000 company at Kansas City, Mo., under the name of The Empire Refining Company. The company will control six refineries, five of which are in Oklahoma and one in Texas. The companies which will be controlled by the new corporation will be American Refining Company, Okmulgee, Okla.; Ponca Refining Company, Ponca City, Okla.; Cushing Refining Company, Cushing, Okla.; Peerless Refining Company, Cushing, Okla.; Oklahoma Refining Company, Oklahoma City, Okla.; Producers' Refining Company, Gainesville, Tex. The six refining companies are engaged in the refining of crude oils in Oklahoma and Texas. The Empire Pipeline Company owns tankage and pipe lines around the Eldorado and Augusta oil fields, which the Henry L. Doherty interests discovered. It is intended, when these pipe lines are completed, that they will furnish the Eldorado and Augusta oil to the various refineries owned by the Empire Refining Company. The total capacity of these refineries at present is about 30,000 barrels per day.

Dragon Paper Mfg. Co., Inc., New York City, has been incorporated with a capital of \$25,000 to manufacture paper specialties, twine. The incorporators are B. G. Bernstein, G. S. and M. Bleyer, 48 West Fifteenth Street.

Eagle-Picher Lead Co., Joplin, Mo., has been incorporated with a capital of \$10,000,000.

General Graphite Co., Birmingham, Ala., has been incorporated with a capital of \$1,500,000 to mine and deal in graphite, mica, gold, silver and copper. The incorporators are J. Stanford, Clark T. Dorman, M. A. Ferguson, Birmingham, Ala.

Gold Chemical Powder Mfg. Co., Inc., has been incorporated with a capital of \$5,000. The incorporators are A. Danizer, C. and J. Davis, Harrison, N. J.

The Granger Clay Products Company, Granger, Wash., has been incorporated in Washington with a capital of \$10,000 by M. C. Peterson, S. H. Dickinson, and H. B. Wilson.

H. & H. Foundry Co., Stamford, Mass., has been incorporated with a capital of \$20,000 to do a foundry business. The incorporators are B. Harris, Stamford; J. Hansen, East Port Chester; C. Pond Webb, Stamford.

William Harvey Corporation has been incorporated with a capital of \$250,000 to manufacture tin, lead, zinc and barvta iron, copper, gold, silver, by products. The incorporators are G. D. Dorsey, R. F. Pearce, E. J. Cornish, 111 Broadway.

Helburn-Thompson Co., Salem, Mass., has been incorporated to conduct a general tanning and leather business.

S. Henle, Inc., New York City, has been incorporated with a capital of \$50,000 to manufacture paraffin, petroleum, greases, lubricating oils. The incorporators are W. H. Warde, G. R. Martin, S. Henle, 25 Beaver Street.

The Hopkins Fertilizer Co., New Albany, Ind., has increased its capital from \$50,000 to \$150,000.

Hydro-Carbon Gas Co., Inc., Dover, Del., has been incorporated with a capital of \$1,000,000 to manufacture gas machinery, merchandise. The incorporator is O. U. Bean, 42 Broadway, Manhattan.

Hygeian Manufacturing Co., Dallas, Tex., has been incorporated with a capital stock of \$26,000 to manufacture chemicals and by-products thereof. The incorporators are E. F. Ballard, A. A. Clarke and H. C. Jarrel.

Inland Steel Co., Dover, Del., has been incorporated with a capital of \$30,000,000 to manufacture iron, steel, copper, lead, zinc and metallic compounds of all kinds. The incorporators are Herbert E. Latter, Norman P. Coffin and Clement M. Egner, all of Wilmington, Del.

International Manganese Co., Portland, Me., has been incorporated with a capital of \$500,000 to deal in general mining, quarrying, smelting, preparing for market, etc., all kinds of metals, ores, minerals, etc. The president is William M. Riddle, Boston, Mass.

The Jakes Foundry Co., Nashville, Tenn., has been incorporated with a capital of \$10,000. The incorporators are Robert

Jakes, J. W. Jakes, E. F. Jakes Robert Jakes, Jr., and Lee Parish.

The Victor E. Knecht Foundry Company, Harrison, Ohio, has been incorporated with a capital of \$6,000. The incorporators are Victor E. Knecht and others.

The Lead Queen Mining & Milling Company, Spokane, Wash., has been incorporated in Washington, with a capital of \$1,000,000 by T. D. Bevan, A. S. Nichols, Louis Morgan, E. M. Steele and A. C. Shaw.

The Lehigh Valley Coke Company interests, which were held by the Berlin Anhalter Machine Construction Co. and the Stettinger Channotte Co., are understood to have been sold to the Bethlehem Steel Co. for \$7,000,000.

The Linoil Products Company, Seattle, has been incorporated in Washington with \$50,000 capital by Ben M. Harris, J. A. Reubens and C. Newman.

The Marion Glass Manufacturing Co., Marion, Ohio, has been incorporated with a capital of \$50,000. Incorporator, G. L. Kraatz.

Missouri Plate-Glass Co., St. Louis, Mo., has been incorporated with a capital of \$1,500,000 to manufacture and sell glass. The incorporators are R. Francis, Herculaneum, Mo., H. A. Baumann, C. B. Johnson and R. R. Baumann.

H. C. Mooney Co., 68 Chestnut Street, Newark, N. J., has been incorporated with a capital of \$10,000 to manufacture paper, paper products, etc.

New Jersey Dye Stuffs, corporation, Paterson, has been incorporated with a capital of \$25,000 to manufacture dye stuffs, etc. The incorporators are Rudolph Schroeder, Robert Rieser and Nathan Marcus, of Hoboken.

New York Fibre Co., Inc., Brooklyn, N. Y., has been incorporated with a capital of \$10,000 to manufacture felts. The incorporators are H. S. Schamel, B. Diamond, M. Spiewack, 1213 Forty-first Street, Brooklyn.

The New York Quinine and Chemical Works, Ltd., New York, has reduced its capital from \$294,000 to \$10,000.

The Ohio Copper Co., Utah, with a capital of \$2,500,000, has filed application for business rights in Utah. The company was incorporated originally in Maine. Stanley B. Sherman is president.

Ohio Mold and Foundry Co., Cincinnati, Ohio, has increased its capital from \$100,000 to \$150,000.

The Old Dominion Chemical Company, of Yorktown, Va., has been chartered, with \$275,000 capital. Officers are: Andrew D. Christian, president; E. S. Bolen, secretary-treasurer, both of Richmond, Va.

Park Utah Mining Co., New York, has been incorporated with a capital of \$1,250,000 to carry on a general mining business. The incorporators are H. L. Nehring, N. Y., Jas. F. Rogan, Brooklyn, N. Y., Frederick Hilderbrant, Tompkinsville, N. Y.

The Piqua Bleachery Co., Piqua, Ohio, has been incorporated with a capital of \$10,000. Incorporators are G. R. Fairborn, W. D. Frye, James Farley.

Radium Chemical Company, has been incorporated with a capital of \$750,000 to manufacture everything in chemistry and chemicals also to manufacture tin containers, to obtain formulas to manufacture any and all articles. The incorporators are: President, L. J. Coleman, Augusta; treasurer, M. F. Hearin, Augusta; clerk, C. L. Andrews, Augusta; directors, L. J. Coleman, E. B. Turner and M. F. Hearin, all of Augusta.

Rainy River Pulp Paper Co. has been incorporated with a capital of \$1,000,000 to operate lumber mills, pulp and paper mills. The incorporators are M. J. Sweeney, J. M. Bengner, Spokane, Wash.; H. L. McNair, Wallace, Idaho.

Reed Distributing Company, Paterson, N. J., has been incorporated with a capital of \$50,000 to manufacture chemicals of all kinds. The incorporators are Richard S. Colfax of Pompton, and Henry M. Van Buren and Joseph R. Lambert of Paterson.

The Rocmac Company, 972 Arcade Building, Cleveland, Ohio, has been incorporated under the laws of Ohio to market Rocmac, a liquid silicate binder used for highways. The company will maintain a complete laboratory for testing materials to be used in connection with Rocmac.

The Scrape-No-More Chemical Company, Cincinnati, Ohio, has been incorporated with a capital of \$10,000. Incorporators are Earl S. Hall, George J. Boehm, Miriam Naddy, Alice C. Roubush, Allen P. Lockwood.

Sinclair Central American Oil Corporation, New York, has been incorporated with a capital of \$5,000,000. The incorporators are A. J. Gathercole, F. H. Butehore, H. Thomson, 37 Wall Street, Manhattan.

Southern Carbon Co., Wilmington, Del., has been incorporated with a capital of \$450,000, to deal in carbon and gas.

The Spokane-Benton County Natural Gas Company, Spokane, has been incorporated in Washington by Herbert C. Harris, J. B.

Valentine and John McGonigle. Capital \$1,500,000.

The Standard Oil Company of Indiana has increased its capital from \$30,000,000 to \$100,000,000.

Taylor Coupler & Steel Castings Co., Toledo, Ohio, has been incorporated with a capital of \$100,000. The incorporators are J. C. Taylor and L. C. Dukes.

The Tiemann Chemical Company, Inc., of New York City, has been incorporated with a capital of \$50,000. Adolph Hoesch, Brooklyn, is a director.

The Warren Lubricating Co., Buffalo, N. Y., has been incorporated with a capital of \$50,000 to manufacture chemicals, vegetable oils and petroleum. The incorporators are M. M. Sanderson of Buffalo, A. J. Squier of New York City and H. N. Squire of Scranton, Pa.

The Western Talc Company, Everett, Wash., has been incorporated in Washington with \$100,000 capital by Douglas F. Smith, K. I. Kobbering and George W. Stryker.

Winchester Hayden, Powell, Inc., has been formed in Massachusetts with a capital of \$50,000. The officials are Howard L. Winchester, president; Samuel H. Hayden, treasurer, and William A. Powell, vice-president. Mr. Winchester was one of the leading factors in the financing of the Iron Cap Copper Company, and recently financed the Gold Cup Mining Company, having been elected president in December last. Mr. Hayden is a manufacturer of Haverhill. William A. Powell was for 15 years managing editor of the Boston Financial News. The business of the company will principally consist of financing and managing mining and industrial enterprises.

Worth Steel Co., Coatesville, Pa., has been incorporated with a capital of \$2,500,000 to manufacture, deal in and with iron, steel, manganese, etc. The incorporators are W. P. Worth, E. H. Worth, W. A. Worth, N. T. Entekin, all of Coatesville.

The Yellowstone Gold Mining Company, Spokane, has been incorporated in Washington with a capital of \$100,000 by William Carr, and Alfred J. Carr.

Brigham Young, Jr., Wilmington, Del., has been incorporated with a capital of \$50,000 to manufacture, sell and deal in and with patent medicines, drugs, chemicals, etc. The incorporators are C. Fearon, K. M. Dougherty, E. Lynch, all of Wilmington.

## Construction and Operation

### Arizona

JEROME.—The United Verde Extension Company has appropriated \$2,500,000 for the company's new smelting plant at Cottonwood on the Verde River. Additions to the Clarkdale smelter will enable that plant to turn out 6,500,000 lb. of copper per month during 1917.

### California

LOS ANGELES.—A Mr. Hienz of San Francisco has purchased the sugar factory at Waverly, Wash., and will move the machinery to Los Angeles where a new factory will be erected.

PITTSBURG.—The Great Western Electrochemical Company is making additions to its plant which will give it an increased capacity of 25 per cent. The manufacture of other chlorine products will be taken up in addition to the caustic soda and bleaching powder.

SAN FRANCISCO.—The Crockett refinery of the California & Hawaiian Sugar Company will be enlarged at a cost of \$2,500,000. The work will take two years to complete and will increase the refining capacity from 900 to 1300 tons per day.

SAN FRANCISCO.—Mr. P. S. du Pont of the Du Pont Company recently made a visit to California. It is understood that examinations are being made with a view to establishing a potash plant manufacturing potash from seaweed.

### Connecticut

BRISTOL.—The Bristol Brass Company will soon begin work upon two new factory buildings, one of which will be used as an addition to the casting plant.

DERBY.—The mill of the old Derby Paper Company, recently damaged by fire, is being repaired and will be occupied by a company headed by Joseph Willmann, president of the Derby Manufacturing Company. The new company will manufacture crucibles or melting pots for brass.

WATERBURY.—The Chase Metal Works

Corporation will erect four factory additions to its plant.

### Delaware

NEW CASTLE.—The Deemer Steel Casting Company will make improvements to its plant costing about \$30,000.

The Belmont Iron Company will construct an addition to its foundry.

### Georgia

SAVANNAH.—The American Sugar Refining Company has considered a location for a proposed \$5,000,000 plant here. Savannah is considered a good location on account of shipping facilities to Cuba.

### Illinois

JOLIET.—The Kerstone Steel & Wire Company will erect a plant here. Mr. Julian Kennedy of Pittsburgh is engineer in charge of the design and construction. Mr. Barton R. Shover, formerly superintendent of the Brier Hill Steel Company, has been retained as electrical engineer on the power equipment.

### Indiana

ATTICA.—The Harrison Steel Company will erect a \$300,000 steel castings foundry. Mr. J. W. Harrison, president of the National Car Coupler Company, will be in charge of the erection.

### Kentucky

LOUISVILLE.—The Hopkins Fertilizer Company of New Albany has increased its capital from \$50,000 to \$150,000 and will use the increased capital in additions and improvements.

LOUISVILLE.—A syndicate of New York capitalists, headed by A. H. Benisch, is reported to have bought for \$400,000 the property of the Kentucky Refining Company in Louisville, which has been in liquidation for the past several years. The syndicate proposes to establish a refinery there for crude oil from the Irvine, Ky., field, according to reports from that place.

The Kentucky Refining Company's plant is located at 1303-1333 South Shelby street, and was formerly used as a cotton seed oil refining plant. The entire property embraces almost six acres of ground, and is improved with several large buildings. Part of the property, including machinery and rolling stock, was sold to Campbell, Health & Co., bankers of New York City, by the creditors' committee, of which Embury L. Swearingen was chairman. An option was given on the balance of the property, including the real estate.

An official of the Standard Oil Company said nothing had come to his knowledge of such a deal, and that in view of the character of the Kentucky Refining plant it did not seem it would be available for petroleum refining. This process requires great acreage owing to the necessity for large and numerous storage tanks for both refined and crude oil.

### Louisiana

MONROE.—The Columbia Carbon Company, of Monroe, La., will erect a plant at Spyker, La., to manufacture carbon and other products of natural gas, and has contracted with the Progressive Oil & Gas Company of Monroe for 2,000,000 ft. of gas daily. Its capital has been increased from \$75,000 to \$200,000.

NEW ORLEANS.—The National Smelting & Refining Company has begun construction of a \$25,000 smelting plant on a site recently purchased here. It is located at Carrollton Avenue and the Illinois Central Railroad. The company will manufacture type metal, babbit metal, and ingot products of various other metals.

### Maine

BANGOR.—The new pulp bleaching plant being erected by Eastern Manufacturing Company at its big plant in South Brewer is practically completed. The new building is located just north of the present main pulp mill between the mill and the electrochemical plant erected last spring.

### Maryland

BALTIMORE.—The American Refractories Company will move its plant from Joliet, Ill., to Baltimore. The company will manufacture glass which refracts light, including telescopes, dark bottles and prism. The sand and other raw material come from Austria and it was for this reason that the company located in Baltimore. The plant

will cover about 20 acres and it is believed that the factory will be ready for operation by the time shipping facilities become normal again.

BALTIMORE.—The International Pulp & Wood Company will shortly begin the erection of a large factory on Franklin Street to cost about \$40,000.

BALTIMORE.—The Bethlehem Steel Corporation according to announcement made by Charles M. Schwab plans the erection of a \$40,000,000 plant here which will be the largest on the Atlantic Coast.

### Massachusetts

ADAMS.—The Berkshire Hills Paper Company will double the capacity of the present plant by the addition of a second unit. A new beater and drainer building, a new engine and power house, and a new finishing department will be erected.

SPRINGFIELD.—Mr. Paul M. Klugler of Springfield, and Mr. Albert Jacob of Rochester, N. Y., are planning the erection of a foundry at East and Ferry Streets.

WALTHAM.—A license has been granted to the National Product Company to conduct an oil distilling plant at Roberts and for storage of 50,000 gal. of oil in underground tanks. The local Board of Health had a long discussion over this, but finally decided to grant a license, provided no gas be allowed to escape. A report on the project was made by Dr. Arthur D. Little of Boston.

### Michigan

SAGINAW.—The Saginaw Malleable Iron Company, recently organized with a capitalization of \$350,000, is completing plans for a factory, suitable for producing 12,000 tons per year. It will employ about 450 men. Mr. C. F. Drozeski has severed his connection with the Illinois Malleable Company to become manager of the Saginaw Company.

### Minnesota

ST. PAUL.—Reported Northern Star Rubber Company, New York Life Building, plans erecting factory building in Midway district to cost from \$175,000 to \$250,000.

### Mississippi

HATTIESBURG.—The Hattiesburg wood reduction plant, which has been closed down for some time, will renew operations in the very near future, it was announced recently. This plant was built at a cost of about \$100,000, and had never been operated to the satisfaction of the stockholders. They had manufactured turpentine and its by-products, but had not installed machinery to extract rosin from pine knots and stumps. Recently the Dantzier interests at Moss Point became interested in the proposition to the extent of buying stock and taking charge of the plant. They now have a number of skilled workmen at the plant getting the machinery in working condition and in the near future will have the plant going at full blast. The plant will use possibly fifty cords of wood each day and will employ a large number of men in addition to giving a market for pine stumps, knots, etc., with which the cut-over lands of Mississippi are literally covered.

### Missouri

EAST CARONDELET.—The Roxana Petroleum Company plans the construction of a pipe line from the Oklahoma wells to St. Louis and the erection of a large refinery at this place.

ST. LOUIS.—According to advices from Washington, the government is contemplating taking over carbon manufacturing plants. This would affect one factory in the St. Louis district; the American Carbon & Battery Company of East St. Louis. The plant has a capacity of 15,000 flashlight batteries and No. 6 cells a day. The Government would use the plants to equip the navy with flashlights and dry batteries.

### Montana

ANACONDA.—The Ohio Copper Mining Company has decided to install the flotation process for handling its slimes. A report reads as follows:

"The Ohio Copper Mining Company has ordered oil flotation equipment for the treatment of 150 tons of slimes daily from the present mill. The present mill is handling 2000 to 2200 tons of ore per diem, and the slimes from this tonnage amount to about



60 tons daily. The mill is recovering between 40 and 45 per cent of the values in the ore. The ore, and more particularly the copper in the ore, slimes excessively and the values in the slimes have heretofore been largely lost by water concentration. Oil flotation was recommended in 1913 by M. W. Atwater, but the recommendations were not followed by the former management. With oil flotation it is expected that recoveries may improve to 60 or 70 per cent, and some optimistic estimates even figure 80 per cent. The ore runs about 1 per cent copper. The new management proposes to increase milling capacity to 3000 tons daily.

**LIBBY.**—Hazel-Luckens silver and lead mine will erect mill to cost \$150,000.

### New Jersey

**HARRISON.**—The new plant being erected by Reuther Bros. on Seventh Street, Harrison, will consist of a main foundry and several buildings.

**NEWARK.**—The Indian Refining Company, which has a plant on the Kearny Meadows, will erect a \$20,000 addition, including 20 tanks.

The Egyptian Lacquer Company will erect an office building, boiler house and distilling plant to cost \$50,000 at its plant in Passaic Avenue.

**NEWARK.**—The Central Dye Stuff & Chemical Company has commenced erecting a four-story warehouse, 75 x 129 ft. This is the latest addition to the large group of buildings which this firm has built during the last two years. Dr. George Prochazka is president of the company.

**NEWARK.**—The Martin Dennis Company, 359 Sumner Avenue, manufacturer of tanners' chemicals, has increased its capital from \$600,000 to \$1,000,000 for extensions.

**NEWARK.**—The General Leather Company will build a one-story addition, 28 x 114 ft., to its plant at 422-38 Frelinghuysen Avenue, for the manufacture of bleach liquor. The addition will cost \$15,000.

**NEWARK.**—The Gerhard Mennen Chemical Company, 42 Orange Street, has increased its capital from \$50,000 to \$1,000,000 for extensions.

### New York

**BROOKLYN.**—De Voe & Reynolds, Fulton and William Streets, New York City, N. Y., headquarters, paint manufacturers, has awarded the American Concrete Steel Company the general contract for the erection of a \$100,000 factory at Huntington, Smith and Ninth Streets. The building will be two stories high, 185 x 100 ft., of reinforced concrete construction.

**DUNKIRK.**—The Atlas Crucible Steel Company will erect a large electric furnace foundry on Howard Avenue.

**DUNKIRK.**—Mr. Fredericks, formerly manager of the Dunkirk Glass Company, plans the erection of a \$100,000 plant directly opposite the plant of the Dunkirk Glass Company.

### Ohio

**AKRON.**—The United States Steel Corporation has purchased 800 acres of land near Akron for the erection of a large steel plant, according to a report.

**CINCINNATI.**—The Ohio Mold & Foundry Company of Pittsburgh has purchased the plant of the Lane & Bodley Company, of Bond Hill. It will make ingot molds for use in steel mills.

**CINCINNATI.**—Linde Air Products Company of New York has received a permit to erect a one-story factory to cost \$45,000. The factory will be used for manufacturing oxygen.

**COLUMBUS.**—The Standard Glass Products Company of this city is equipping a plant to make various kinds of glass lamps and laboratory and chemical glass. Mr. J. Z. Krum is one of the incorporators.

**COLUMBUS.**—The Federal Chemical Company of Louisville, Ky., has purchased a site at Bonham Avenue and Pennsylvania Railroad and plans a factory to cost \$125,000 for manufacturing dyes.

**COLUMBUS.**—The Columbus Glass Products Company, a new company which will manufacture glass for laboratory use, has commenced operation.

**COLUMBUS.**—The Perry Chemical Company has recently been organized by a number of Columbus capitalists and engineers. Experiments which have been conducted with salt water occurring in the Niagara limestone formation in Athens and Perry counties, in the production of salt, calcium chloride and bromine, resulted in the formation of the company. An experimental plant is located at New Straitsville.

Plans are being prepared for the erection of a number of adequate buildings. Edmund De Muth is president of the concern and Dr. Joseph Price vice-president.

**MARION.**—A \$250,000 glass plant, to manufacture various kinds of ware will be located in Marion. This announcement came from the Chamber of Commerce. Mr. Geo. L. Kraatz, of Pittsburgh, is president of the company.

**MINERAL RIDGE.**—The Ohio Steel Products Company plans a large addition to its present plant. The firm manufactures steel tubing.

**YOUNGSTOWN.**—The Basic Steel Company, a subsidiary of the Deforest Sheet & Tinplate Company, will erect a steel plant here in the near future. The Deforest Company requires about 80,000 tons of raw steel annually, and the Basic Company's plant will be built to help supply this.

**STUBENVILLE.**—The United States Steel Casting Company, capitalized at \$1,000,000, has been recently organized and has taken over the National Steel Casting Company of New Cumberland. The company contemplates a number of new foundries in this section.

### Oklahoma

**HARTLESVILLE.**—The Mid-Continent Gasoline Company plans to expend \$2,000,000 in building a power plant to furnish power and light for the oil fields. It is expected that this will be followed by a general movement to electrify the oil fields doing away with gas engines in pumping wells and using motors. The company expects to greatly increase its output of casing head gasoline in the near future.

**MIAMI.**—The First National Mining Company has let a contract for the erection of a 250-ton mill. Mr. H. C. Austin of Oklahoma City is president of the company.

**SAND SPRING.**—The Great American Refining Company, capitalized at \$10,000,000, is seeking a suitable site in the Mid-Continent field for a large refinery. This will make the fourth refinery planned by this company.

### Pennsylvania

**ALLENTOWN.**—The Atlantic Potash Company has purchased the old plant of the Northampton Cement Company at Stockerton, and is making repairs to improve it and will operate in the near future.

**CARBONDALE.**—The Griebel Instrument Company has purchased a property on River Street and will alter same and convert it into a plant for manufacturing thermometers and chemical supplies.

**HARRISBURG.**—One of the largest open hearth furnaces in the United States is now in the course of erection at the Central Iron & Steel Company plant, where a large addition that will greatly increase the production of steel is under way. This furnace will be able to dump 130 tons of steel at each heat. The usual tonnage for furnaces is about 50 tons, according to steel experts. Workmen also are rebuilding the plant's blast furnaces and extending the gas producers. A new 150 ton crane, needed to take care of the proposed increased output, has just been put in operation. What is known as Paxton furnace No. 2 is being reconstructed along modern lines. Under a contract let to the Bethlehem Steel Company a large building approximately 180 ft. long is being erected to take care of increased business. This and the other improvements planned by this South Harrisburg company are expected to be ready by May 1.

**MARIETTA.**—E. J. Lavino & Company, Philadelphia, have purchased the old Vesta furnace formerly operated by the Susquehanna Iron Company. The plant will be remodeled and rebuilt and equipped for the production of manganese.

**PHILADELPHIA.**—The American Metal Works will erect a two-story factory, 42 by 113 ft., at Loudon Street and Stenton Avenue.

**PHILADELPHIA.**—The American Metal Works is erecting a two-story brick addition, 40 x 110 ft.

**PHILADELPHIA.**—Rohm & Haas will build a two and one-half-story addition, about 32 x 52 ft., to their chemical plant at Bristol, Pa.

**POTTSTOWN.**—The Nagle Steel Company has purchased from the Potts Brothers Iron Company its property at Ollstown, Pa. Improvements will be made to the mill.

**READING.**—The Reading Chemical Company is planning for extensions to its plant at North Reading for the manufacture of medicinal chemicals and dyes. The company has recently increased its capital from

\$200,000 to \$1,000,000. E. H. Deysher is president.

**VANDERGRIFT.**—The United States Steel Corporation plans improvement amounting to \$1,000,000 to its plant here. D. A. Barrett, formerly superintendent of the Aetna-Standard plant, is the head of the plant which is one of the largest sheet mills owned by the company.

### Tennessee

**NEWPORT.**—A Cincinnati engineer has been making tests and samples of manganese and iron ore, and it is expected that a \$250,000 plant will be erected here in the near future, to smelt this ore.

### Washington

**ABERDEEN.**—Mr. R. S. Talbor of the Inland Empire Pulp & Paper Company of Spokane, Wash., is heading a project which contemplates the erection of a \$750,000 paper mill, which will have a capacity for 50 tons daily.

**SEATTLE.**—The Seattle Brewing & Malt- ing Company is trying out experimentally the Cozzolino process for extracting alcohol from beer. Mr. Heinrich Schweitjeger is chemist.

**SEDRO WOOLLEY.**—The Washington Steel & Iron Company, with offices at Spokane, has ordered equipment for a plant which will cost about \$30,000 to smelt pig iron. Mr. O. L. Moore is manager. The furnaces will be oil burning, and it is considered to be somewhat of an experiment.

### West Virginia

**CHARLESTON.**—The new plant being erected at South Charleston by E. C. Klipstein & Sons Company of New York City is being rushed to completion. The plant will be used for the manufacture of dyes and is expected to be ready in the spring. The main or manufacturing building will be four stories high and 60 x 120 ft. A good size laboratory has also been provided for.

**WHEELING.**—The Wheeling Chemical Products Company, with offices at Thirty-first and Jacob Streets, will have a daily capacity of 40,000,000 matches, 1500 lb. of glue, 1000 lb. of paste and 1000 lb. of nitrated products. It is also building its own machinery and will occupy the quarters formerly used by the Uneeda Brewing Company. The officers are: A. A. Schramm, president; H. C. Kalbetzer, vice-president; E. S. Romine, secretary, and O. V. Snyder, manager.

### Wisconsin

**MILWAUKEE.**—The Hercules Steel Casting Company, a new concern capitalized at \$400,000, will erect a large plant, 500 x 70 ft. The incorporators of the company are F. E. McIntyre, E. B. Gennrich and Dr. J. J. McGovern, all of Milwaukee.

## Manufacturers' Notes

**ANNUAL MEETING OF GREAT WESTERN ELECTROCHEMICAL.**—The following directors were elected for this year at the annual meeting of the Great Western Electrochemical Company of Pittsburg, California: Franklin Remington, H. A. Wilson, Clem Bowen of Detroit, John F. Bush, Mortimer Fleishacker, Sigmund Stern, Herbert Fleishacker and Arthur Lillenthal.

At a subsequent meeting the following officers were elected: Mortimer Fleishacker, president; John F. Bush, vice-president and general manager, and Arthur Lillenthal, secretary and treasurer.

Its average net earnings in 1916 were very heavy on the actual paid up cash capital of \$600,000.

At the annual meeting a report was read showing that the plant was operating at its full capacity and producing 40 tons of caustic soda and bleaching powder a day.

The stockholders unanimously ratified the proposition of the directors to increase the capacity of the plant forthwith and an order has been placed with the General Electric Company for new equipment which will increase the output of the products now manufactured about 25 per cent.

The stockholders also approved the plan of embarking on the manufacture of liquid chlorine, carbontetrachloride and chlorate of potassium. These crude chemicals are largely used in oil refining, in the manufacture of matches, in the manufacture of powder and for mining purposes. None of

them has ever been made before on a commercial scale on the Pacific Coast.

In order to provide capital for the enlargement of the plant and its new manufacturing departure, it was decided to raise \$500,000 of additional capital and to offer at once the \$400,000 of 7 per cent cumulative preferred stock now in the treasury at par to the present stockholders.

**ALLEGED CONTAMINATION OF SAGINAW RIVER BY CHEMICAL PLANTS.**—Investigations are under way following complaints of acid and other contaminating substances in the Saginaw River, Michigan. It is expected that action will be taken against all chemical plants in the valley, restraining them from emptying contaminating substances into the river.

**ABANDONED RAILROADS PURCHASED.**—The Idaho Southern Railroad which runs from Gooding to Jerome, Idaho, and the Milner & North Side Railroad, a short line extending from Milner to Oakley, Idaho, comprising a total of approximately 50 miles, have been purchased by the Walter A. Zelnicker Supply Co. of St. Louis, Mo.

These railroads were built only a few years ago by Pittsburgh capital. It is understood the Walter A. Zelnicker Supply Co. will dismantle the roads and sell the rails and other equipment.

**CHEMICAL FUNNELS.**—The Cambridge Glass Co., Cambridge, O., has been making improvements in the manufacture of chemical funnels and has been able to reduce the prices on these funnels considerably. The funnels are manufactured to take the place of those formerly imported.

**TITANIUM ALLOY CO. CHANGES NEW YORK HEADQUARTERS.**—The New York office of the Titanium Alloy Manufacturing Company, of Niagara Falls, N. Y., has been moved from 15 Wall Street, to the City Investing Building, 165 Broadway.

**LARGER SAN FRANCISCO OFFICE FOR WILLIAMS CO.**—The Williams Patent Crusher & Pulverizer Co., of St. Louis, Mo., have taken larger quarters for their Pacific Coast Sales Office at 67 Second Street, San Francisco. The San Francisco office, which has been in charge of Mr. O. J. Williams for a number of years, has developed a very satisfactory trade among the ranchers, for the Williams alfalfa grinder. The new quarters are larger and more centrally located and are connected with a warehouse in which the Williams company maintains a complete stock of spare parts for different types of their grinders.

**STEEL-HARDENING COMPANY EXPANDING.**—The Stroh Steel-Hardening Process Co., of Pittsburgh, Pa., manufacturers of processed steel castings, is planning expansion of its business and has appointed Mr. F. Lloyd Mark western sales manager for the central and near western states, with office at 728 Monadnock Building, Chicago.

**BARSTOW MANAGEMENT ASSOCIATION FORMED.**—W. S. Barstow & Co., New York, announce the incorporation of the W. S. Barstow Management Association, 50 Pine Street, New York, which will supervise the management of all public utility properties controlled by the General Gas & Electric Company, the Eastern Power & Light Corporation and W. S. Barstow & Company, Inc. Mr. E. L. West has been elected president of the new corporation.

**PRODUCTION OF ALUMINUM IN 1916.**—The domestic consumption of aluminum in 1916, according to estimates made by J. M. Hill, of the United States Geological Survey, was over 121,000,000 pounds. The estimates are based on statistics of the domestic production for the year and of the imports for 9 months. This is an increase of more than 21 per cent over the consumption of 1915. These estimates do not include the consumption of secondary aluminum obtained from scrap materials, which is believed to have also increased.

**NEW TIN PRODUCER.**—The following letter was written by the president of the American Tin & Tungsten Company, to the editor of the American Metal Market:

Sir: Our company lately organized under the laws of the State of South Dakota, is now operating the only tin mill in the United States, mining, milling and smelting cassiterite tin ores. Our mill was completed about January 1st, and is now operating on tin and tungsten ores and doing custom work for neighboring mines on tin and tungsten.

The mill has a capacity of about 200 tons at the present time, for which we have sufficient tonnage blocked out, according to engineers reports to run at full capacity, exclusive of the custom ore offered for an indefinite period.

The ore runs about 3 per cent in metallic content, according to a recent letter from

the American Smelting & Refining Company, who have offered to take our entire mill product in concentrates. This product runs 73 per cent, with practically no impurities.

The stock has been sold to St. Louis business and professional men and is entirely a St. Louis institution.

We purchased the property, mill and good will of the Hill City Tungsten Production Company, who developed these properties up to the point where they would show constant production. This has been consummated within the last 30 days.

Some shipments of pig tin have been made to the St. Louis market and we expect to be a factor in the tin producing division of the United States within a short time.

We expect to shortly make application to list the stock on the New York Curb. We have about 500,000 shares in the treasury, which is intended to be used in further development of the properties.

American Tin & Tungsten Co.,  
Simon Lederer, Pres.  
St. Louis, Mo., February 12, 1917.

**A CENTURY OLD CIRCULAR.**—One of the geologists of the Geological Survey found the following interesting "preparedness" circular among some of the papers of Thomas Jefferson. It is dated February 17, 1809, and was issued by a Philadelphia firm of type founders. The circular reads as follows:

The present state of the commerce of the United States, arising out of the conduct of the belligerent powers, having shown our wants, and pointed out the necessity of calling to our aid such of the natural productions of the country as our knowledge and research might enable us to discover; with a view to this important object, we particularly solicit your attention to the article of Antimony, which is essential in the manufacture of Printing Types, and which has not hitherto been discovered in this country. Bismuth would also be a great acquisition, and profitable to the owner of the mine. As it is highly probable that articles, which abound in so many parts of Europe, are not totally wanting in this extensive country, we earnestly request you to make the necessary inquiries in your neighborhood, and, should you discover anything which promises a favourable result, to transmit an account of it to us.

We are, respectfully,  
BINNY & RONALDSON,  
Letter Founders.

**GRAPHITE IN TEXAS.**—Dr. William B. Phillips, who has returned from Burnet and Llano Counties, where he examined the graphite deposits, said the deposits were wonderful and he is confident they can be made the basis of a considerable industry.

In speaking of the graphite deposits in Burnet and Llano Counties, Dr. Phillips said:

"These deposits are of an extraordinary character with respect to quantity and quality and could be made the basis of considerable industry. There is an active demand for nearly all varieties of graphite and prices are good. During the five years ending with 1914 the production of all kinds of graphite in the United States was 20,766 tons, valued at \$1,462,365. During this same period the production of artificial graphite (made by electrical processes from a certain kind of anthracite coal) was 30,138 tons, valued at \$4,111,390. During these same five years the imports of graphite were 122,461 tons, valued at \$8,576,710. Our production of natural and manufactured graphite fell short of our imports by 71,577 tons in weight and \$3,102,955 in value. It is easy to see, therefore, the reason for the interest now being shown in deposits that promise to augment the domestic supply. This is particularly true of flake, or crystalline graphite, the variety that always commands the highest price.

"The principal factor in the value of the Burnet and Llano graphite is that it is of the crystalline variety. It occurs in flakes of varying sizes in the older schists and gneiss of the central mineral region and comprises from 8 to 10 per cent rock. Now and then larger masses of much better grade are found, but with 8 to 10 per cent of flake graphite as mill yield there should be no reason to complain. As with quicksilver, so with graphite, the Texas crude material runs higher in value than elsewhere in the country. Furthermore, most, if not all, of the principal Texas localities are almost free from black mica, the presence of which, with graphite, renders the concentration and purification of the graphite more difficult and costly. If nature had set out to make a deposit of graphite that would yield the best possible product, she could hardly have done more than she has for the Burnet and Llano districts. Enormous quantities of a crude material exist carrying from 8 to 10 per cent of flake graphite and an ideal climate, good and excellent weather and a market already assured.

"There are less than ten establishments in the entire country making flake graphite, three or four in Alabama, two in New York, one in Pennsylvania and one in Montana. All of these, together with the plant at Niagara Falls, making artificial graphite, do not begin to supply the demand for graphite. For every ton of natural graphite produced we import from five to six tons."

## Manufacturers' Catalogs

**CHARLES MUNDT & SONS**, 53-65 Fairmount Ave., Jersey City, N. J., have issued a little book containing illustrations of the different sized perforations which can be made on metal or other material as required.

**FIRE DETECTING WIRE CO., Inc.**, 101 Park Ave., New York City, have issued a little booklet on Fire Detection, describing the Fire Detecting Wire System.

**GORDON ENGINEERING CORPORATION**, 96 Broadway, New York, have issued catalog C, describing their standard compartment dryer for drying chemicals, colors, paints, leather, rubber, etc.

**ROBINSON CLAY PRODUCT CO.**, Akron, Ohio, have issued catalog D, which illustrates specialties in chemical stone-ware used in chemical industries, laboratories, etc., which are regularly required in the chemical industry.

**HERMAN A. HOLZ**, 50 Church Street, New York City, has issued a booklet on the Erichsen Machine for Testing Metal Sheets.

**THE PFAUDLER CO.**, Rochester, New York, have issued a booklet on glass-enamelled steel apparatus. It is entitled Chemical Trades, Bulletin C-4.

**MONARCH ENGINEERING & MFG. CO.**, 1206 American Building, Baltimore, Md., have issued a booklet entitled "Crucible Problem Solved," describing Monarch smelting and heating furnaces without crucibles.

**VANADIUM-ALLOYS STEEL COMPANY**, Pittsburgh, Pa., has issued a folder descriptive of its Vasco Special, Vasco Electric and Vasco Latrobe Carbon Tool Steels.

**STEVENS BROTHERS**, 149 Broadway, N. Y., has issued a loose leaf catalog of its chemical equipment of metal.

## Other New Publications

**FAILURE OF BRASS.**—1-Microstructure and Initial Stresses in Wrought Brasses of the Type 60 Per Cent Copper and 40 Per Cent Zinc. By Paul D. Merica and R. W. Woodward. Technologic Paper of the Bureau of Standards, Bulletin No. 82 issued by the Department of Commerce, January 29, 1917.

**COLORIMETRIC TEST FOR ORGANIC IMPURITIES IN SANDS.**—By Duff A. Abrams and Oscar E. Harder. Circular No. 1 of the Structural Materials Research Laboratory With the Cooperation of the Portland Cement Association and Lewis Institute, Chicago, issued February, 1917.

**NICKEL IN 1915.**—By Frank L. Hess, issued by the Department of the Interior, Geological Survey.

**PHYSICAL AND CHEMICAL PROPERTIES OF GASOLINES SOLD THROUGHOUT THE UNITED STATES DURING THE CALENDAR YEAR 1915.**—By W. F. Rittman, W. A. Jacobs and E. W. Dean. Technical Paper 163, Petroleum Technology 38, issued by the Department of the Interior, Bureau of Mines, November, 1916.

**REFINING AND UTILIZATION OF GEORGIE KAOLINS.**—By Ira E. Sproat. Bulletin 128, Mineral Technology 18, issued by the Department of the Interior, Bureau of Mines, October, 1916.

**COBALT ALLOYS WITH NON-CORROSIVE PROPERTIES.**—By Herbert T. Kalmus and K. B. Blake. Part IV of a series of books published by the Canada Department of Mines, Mines Branch, Ottawa, Canada, 1916, No. 411, dealing with researches on cobalt and cobalt alloys, conducted at Queens University, Kingston, Ontario, for the Mines Branch of the Department of Mines.

**MAGNESIUM IN 1915.**—The Annual statement issued by the United States Geological Survey, Department of the Interior, on Magnesium in 1915 which is ready for distribution.

**MAGNESITE IN 1915.**—The annual statement on Magnesite in 1915, published by the United States Geological Survey, Department of the Interior, Washington.

**FELDSPAR IN CANADA.**—By Hugh S. de Schmid. A book issued by the Canada Department of Mines, Mines Branch, Ottawa, Canada, 1916, No. 401.

**TUNGSTEN DEPOSITS OF NORTH-WESTERN INYO COUNTY, CAL.**—Bulletin 640-L, issued by the Geological Survey, Washington, D. C.